

**WATER QUALITY OF THE LOWER SAN JOAQUIN RIVER:  
LANDER AVENUE TO VERNALIS, MAY 1985 TO MARCH 1988**

California Regional Water Quality Control Board  
Central Valley Region  
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**WATER QUALITY OF THE LOWER SAN JOAQUIN RIVER:  
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**SUMMARY AND RECOMMENDATIONS**

**Summary**

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985. The objectives of this monitoring program are:

1. to assess existing water quality conditions;
2. to provide a long-term database for assessing the effects of future regulatory actions;
3. to provide a database to assess potential long-term aquatic ecosystem impacts including in-stream biotoxicity testing being conducted by Regional Board staff; and
4. to provide a database to validate the San Joaquin River Input-Output Model (SJR10-1) described in Appendix C of the State Water Resources Control Board (SWRCB) Order No. WQ 85-1 Technical Committee Report on "Regulation of Agricultural Drainage to the San Joaquin River" which was released in August 1987.

Selected mineral and trace element constituents were measured for total recoverable concentrations at eight monitoring sites along a 60-mile section of the San Joaquin River extending from near Stevinson at Lander Avenue to near Vernalis at Airport Way. Water quality samples were collected on a monthly basis and analyzed for electrical conductivity (EC), boron, chloride, total alkalinity, selenium, and, at selected sites, molybdenum.

The general trend in constituent concentrations along the San Joaquin River study area is that the lowest concentrations occur at the upstream and downstream study end points; Lander Avenue and Airport Way, respectively. Concentrations were highest just downstream of Lander Avenue below the Salt Slough and Mud Slough confluences at Fremont Ford and Hills Ferry Road, respectively. Salt and Mud Sloughs are the two major sources of subsurface agricultural drainage to the San Joaquin River. Downstream of the Hills Ferry Road site concentrations decreased as each of the three east side streams diluted the River to a point that concentrations at the downstream study end point at Airport Way were comparable to concentrations found at Lander Avenue, the upstream study end point.

Chloride, boron, sulfate, EC, selenium, and molybdenum values in the river appear to be directly related to climatic and streamflow conditions in the river basin. During the critical 1987 and 1988 water years (WYs) constituent concentrations were routinely higher than they were during the wet 1986 WY.

These same constituents also show seasonal variations in concentrations with the highest levels for a given water year occurring during the nonirrigation season (October to March) regardless of water year type.

Total recoverable copper, chromium, and nickel concentrations were found at unusually high levels during a major storm event in 1986, which suggests that storm events may be times of major loading and transport of these constituents through high sediment levels. Concentrations increased as each of the east side streams flowed into the River. Further storm event data is needed to evaluate the contribution of metals loading from storm events.

### RECOMMENDATIONS

1. Continue the water quality monitoring program on the lower San Joaquin River in cooperation with other agencies. This program should attempt to expand the database to include data from all water year types. The database presently contains data from the latter half of one dry water year, one wet water year, and one and-a-half critical water years. An extended monitoring program will provide information on the long-term variability of the system.
2. Continue, in cooperation with other agencies, the monthly water quality monitoring program at the eight sites along this 60-mile section of the San Joaquin River between Stevinson and Vernalis. The purpose should be to build a long-term database for assessing the effects of proposed regulatory actions to protect the beneficial uses of water in the San Joaquin River.
3. The elevated copper, chromium, and nickel concentrations along the river during the 16 February 1986 storm event suggest that storm events are times of mass transport for certain trace elements in the San Joaquin River. The full extent of this loading needs to be determined in future research studies. Such a study would need to include monitoring the major tributaries, as well as the river to determine the relative contribution from each stream.
4. As Crows Landing is now proposed as the San Joaquin River compliance point, a full trace element scan should be conducted at this monitoring site.
5. Regional Board monitoring for trace elements at key monitoring sites should be changed to collection of samples for dissolved constituents as well as total concentrations. Dissolved levels should be evaluated at the Hills Ferry Road and Crows Landing sites. Dissolved samples should also be obtained from the Airport Way (Vernalis) site, but this effort should be coordinated with existing U.S. Geological Survey and Department of Water Resources sampling efforts to avoid duplication.
6. The present location of monitoring sites at Hills Ferry Road and Crows Landing Road should be maintained as representative of upstream and

downstream of the Merced River inflow, respectively. Due to field observations of inadequate mixing and the lack of data on the extent of mixing, no effort should be made to monitor the San Joaquin River immediately downstream of the Merced River inflow as inadequate mixing occurs in excess of two miles downstream.

7. Due to radical changes in streamflow and resulting river water quality during dry and critical years, more intensive monitoring of key check stations should be conducted during these periods. This increased monitoring would allow better verification of the San Joaquin River Model during low flow conditions and allow increased compliance checks on agricultural drainage discharge load limitations, accretions, and other inflows during this period.

## INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water-quality monitoring program on the lower San Joaquin River in May 1985. Water quality samples were collected at eight monitoring sites along a 60-mile section of the River extending from near Stevinson in Merced County to near Vernalis in San Joaquin County (Figure 1). The purpose of this monitoring program was to compile an ongoing database for selected inorganic constituents found in San Joaquin River water. This database will be used to help assess the effects of agricultural drainage water on the quality of the San Joaquin River. A long-term database is essential to assess the long-term effects of the implementation of regional agricultural drainage reduction programs. This report contains the results of this monitoring program for data collected from May 1985 through March 1988. This monitoring program was designed to complement monitoring programs conducted by other state, federal, and local agencies.

## STUDY AREA

The study area consists of the 60-mile section of the San Joaquin River extending from Lander Avenue (Highway 165) near Stevinson to Airport Way near Vernalis. Monitoring sites are located near each of the eight river overcrossings on this section of the River (Figure 2).

There are five major tributaries to the San Joaquin River within this study area: Salt Slough, Mud Slough, and the Merced, Tuolumne, and Stanislaus Rivers. Salt and Mud Sloughs drain the Grassland Area of western Merced County and discharge to the San Joaquin River in the southern portion of the study area (Figure 2). These two sloughs are the major source of agricultural drainage to the San Joaquin River. They carry a varying mixture of surface and subsurface agricultural drainage, operational spillage from irrigation canals, and seasonal drainage from duck ponds flooded each winter for waterfowl habitat. The Merced, Tuolumne, and Stanislaus Rivers are eastside streams which drain the Sierra Nevada Mountains and contain relatively high quality water.

In addition to the five major tributaries there are also a number of smaller tributaries as well as surface and subsurface agricultural drains that discharge to the San Joaquin River within the study area. A list of these inflows and their locations, referenced by river mile are listed in Table 1. The monitoring sites are also listed in this table.

## TEMPORAL VARIATIONS IN STREAMFLOW

A water year (WY) extends from 1 October of one year to 30 September of the following year. The average yearly flows of the San Joaquin River for the WYs 85-87 are shown in Figure 3 for each of six gaged stations within the study area. The long-term average flow at each station is also indicated for comparison. As shown, streamflows in the 1985 and 1987 WYs were below the long-term average and in the 1986 WY they were above average.

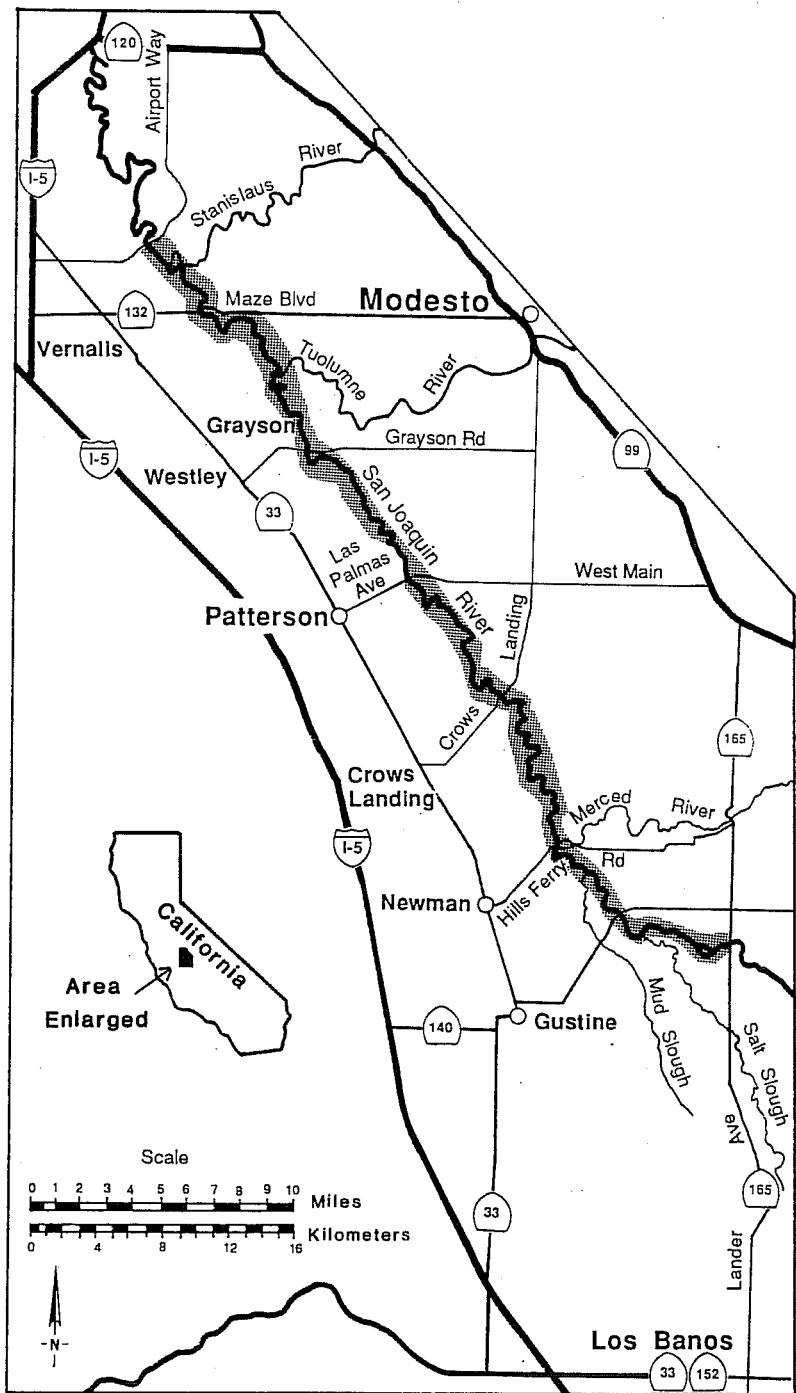


Fig.1. Location Map

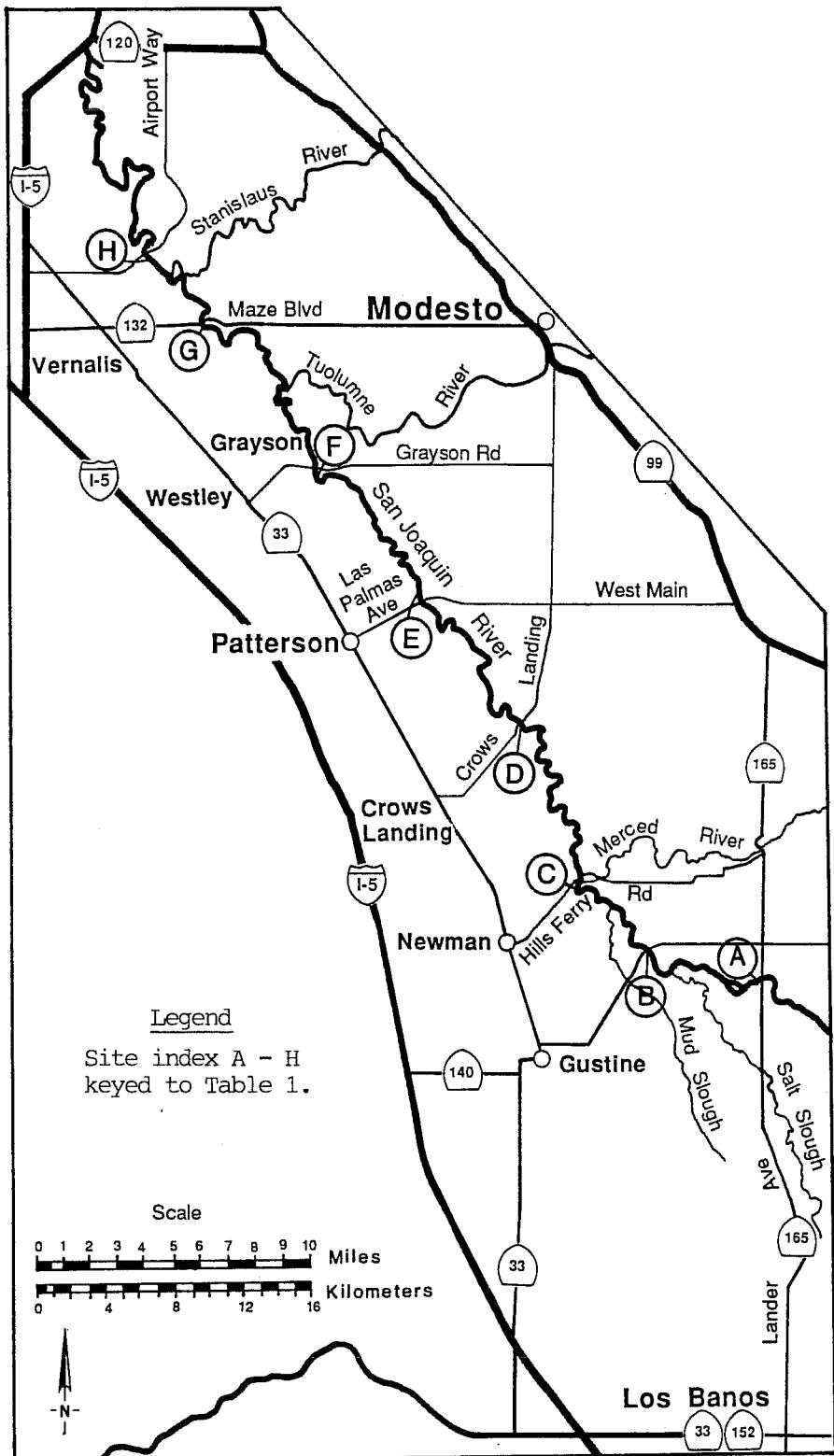


Fig. 2. Index Map

**Table 1. Tributaries and Drains to the San Joaquin River Between Lander Avenue and Airport Way**

River Mile	Description	Type*
132.9	Lander Avenue (Site A)	
129.7	Salt Slough	T,S
125.1	Fremont Ford (Site B)	
121.2	Mud Slough	T,S
119.6	Newman Wasteway	OS
119.5	Newman Drainage District Collector Line A	T
119.1	Hills Ferry Road Drain	S
118.8	<b>Hills Ferry Road (Site C)</b>	
118.2	Merced River	N
117.5	Newman Drainage District Collector Line I	T
117.2	Azevedo Road Drain	S
113.4	Freitas Rd. Drain + south of Freitas Rd. Drain	S
112.0	Turlock Irrigation District Lateral 6	S,O
109.0	Orestimba Creek	N,S
107.2	<b>Crows Landing Road (Site D)</b>	
105.0	Spanish Grant, Marshall Rd., Moran Rd. Drain	S,T
103.5	Turlock Irrigation District Lateral 5	S
100.0	Ramona Lake Main Drain	S,T
098.6	Patterson Water District Main Drain	S,T
098.4	<b>Las Palmas Launching Facility (Site E)</b>	
097.6	Olive Avenue Drain	S
097.3	Lemon Avenue Drain	S
097.0	Eucalyptus Avenue Drain	S
095.2	Turlock Irrigation District Lateral 3	S
092.9	Del Puerto Creek	N,S
091.4	Houk Ranch Drain	S,T
090.3	Turlock Irrigation District Lateral 2	S
089.1	<b>Grayson Road (Site F)</b>	
087.0	Old San Joaquin River Channel	S
083.7	Tuolumne River	N
081.1	Merced Irrigation District Lateral 4	S
079.9	Hospital/Ingram Creeks	S,T
078.9	Center Road Drain	S
077.6	El Solyo Drain	S,T
077.4	Blewett Drain	S
077.3	<b>Maze Boulevard (Site G)</b>	
074.9	Stanislaus River	N
073.6	<b>Airport Way (Site H)</b>	

\* LEGEND

- 
- |   |                               |
|---|-------------------------------|
| S | Surface Agricultural Drain    |
| T | Subsurface Agricultural Drain |
| N | Natural Stream                |
| O | Operational Spillage          |

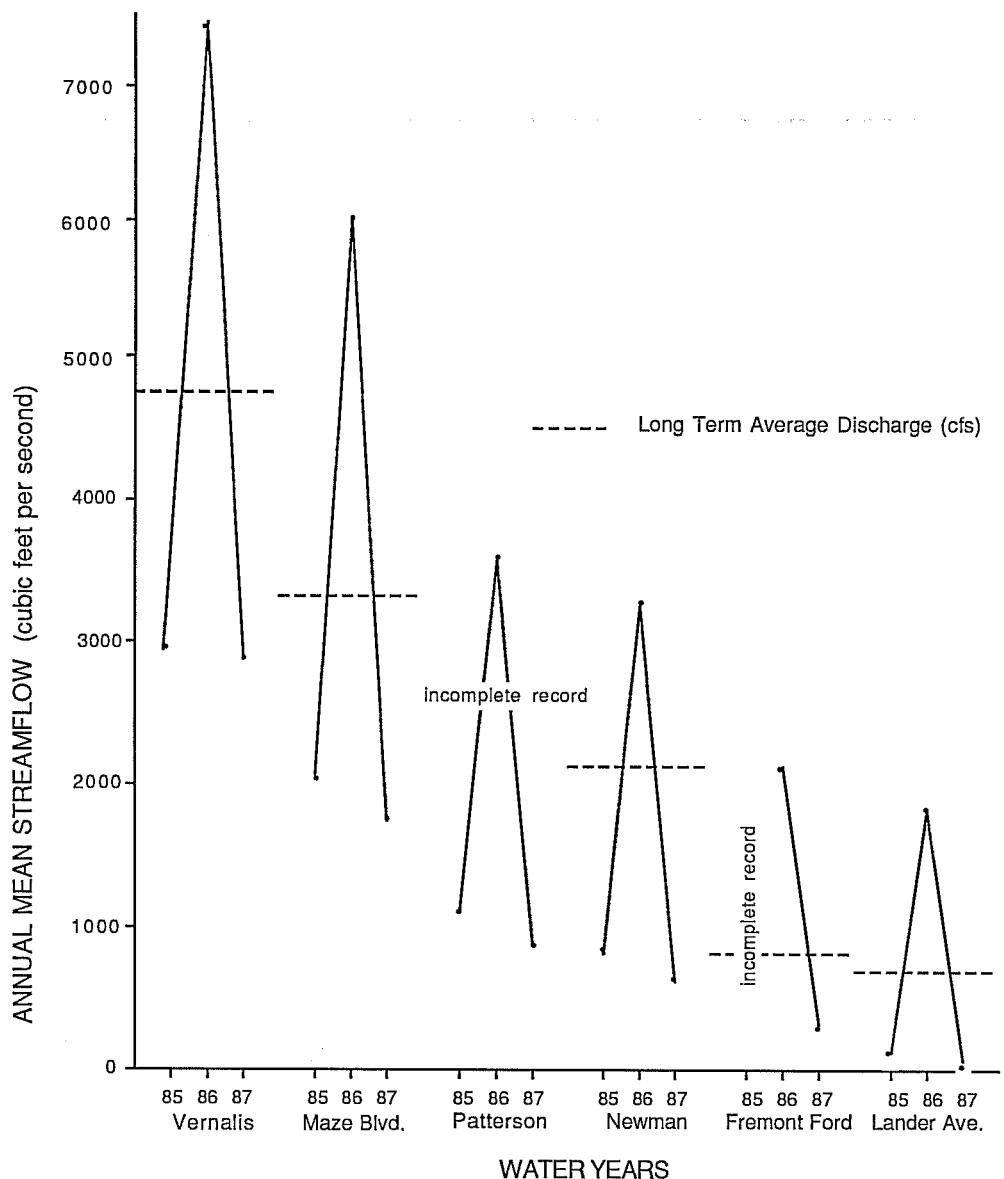


Fig. 3. 1985 - 1987 Annual Mean Streamflow at Gaged Stations on The San Joaquin River Compared to Long Term Average Streamflow at These Sites.

The Water Quality Control Plan Report for the San Joaquin Basin (5C) defined water year types for the San Joaquin Basin based on each year's percentage of the average annual unimpaired flow during the 50-year period from 1922-71. Appendix C of the SWRCB Order No. WQ 85-1 Technical Report on Regulation of Agricultural Drainage to the San Joaquin River expanded this definition to include 80 years of flow data (1906 - 85). The water year types are defined as follows:

<u>Year Type</u>	<u>Total Annual Unimpaired Flow (1,000 AF)</u>	<u>Total Annual Unimpaired Flow for Years Following Critical Years (1,000 AF)</u>
Critical	<3,366	< 4,134
Dry	$3,366 \leq X \leq 4,134$	$4,134 \leq X \leq 5,315$
Normal	$4,134 \leq X \leq 7,382$	$5,315 \leq X \leq 7,382$
Wet	$> 7,382$	$> 7,382$

Based on this definition, the water year types for the past decade are as follows:

<u>WY</u>	<u>Year Type</u>
88	Critical *
87	Critical
86	Wet
85	Dry
84	Normal
83	Wet
82	Wet
81	Critical
80	Wet
79	Normal
78	Wet
77	Critical

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\* 1988 critical year status projected from incomplete record

This study (May 1985 - March 1988) includes the latter half of one dry (1985 WY), one wet (1986 WY), one critical (1987 WY), and the first half of another critical (1988 WY) water year type.

## METHODS

The Regional Board monitoring program for the San Joaquin River began in May 1985. The frequency of sample collection varies, but generally grab samples were collected on a monthly basis to be analyzed for total recoverable selenium, boron, chloride, sulfate, total alkalinity, and electrical conductivity (EC). Selected samples were also analyzed for molybdenum. During 1986, all the monitoring sites were sampled for total recoverable copper, chromium, nickel, lead, zinc, mercury, selenium, molybdenum, and a full general mineral analysis. Beginning in 1987, extensive trace element and full general mineral samples were collected only at the Hills Ferry Road site, while samples for the originally selected constituents (Se, B, Cl, SO<sub>4</sub>, EC, and total alkalinity) continued to be collected at all the sites. Data recorded in the field included time, temperature, pH, and EC.

Selenium and trace element samples were preserved with ultra-pure nitric acid to lower the pH of the sample to two or less. Mineral samples were kept on ice until submitted to the laboratory for analysis. A quality control and quality assurance program was conducted. Spike and duplicate samples were utilized in the laboratory. In addition, blind replicate samples were collected at 10 percent of the sites and 50 percent of the blind replicates were spiked for laboratory quality assurance. Reported results fall within quality assurance tolerance guidelines.

## RESULTS

Concentrations of the measured constituents followed a consistent pattern along the San Joaquin River study area. The lowest concentrations generally occurred at the upstream study end point at Lander Avenue while the highest concentrations occurred just downstream at Fremont Ford and Hills Ferry Road, which are located below the Salt Slough and Mud Slough confluences, respectively (Figure 2). Downstream of the Hills Ferry Road site there was a progression of decreases in constituent concentrations as the Merced, Tuolumne, and Stanislaus Rivers each inflow and dilute the San Joaquin River.

### Mineral Results

Results of water quality analysis for minerals are listed by site in Appendix A, Table 1A. The ranges and median concentrations at each site for selected mineral constituents are shown in Appendix A, Table 2A.

The ranges and median values at each monitoring site are graphically represented for EC, boron, chloride, and sulfate in Appendix B, Figures B1 through B4, respectively. These graphs show the general trend in the concentrations of these selected minerals along the entire study area. The lowest concentrations occurred at Lander Avenue, the upstream study end point, while the highest concentrations occurred at the next two downstream sites, Fremont Ford and Hills Ferry Road. Downstream of the Hills Ferry Road

site the Merced River inflows and dilutes the river so concentrations of these minerals at the next three sites downstream are lower than at Hills Ferry Road. These three sites, Crows Landing, Las Palmas Avenue, and Grayson Road, are located between the Merced and Tuolumne Rivers and their mineral concentrations are essentially the same. The mineral concentrations were further reduced in the river downstream of the Tuolumne and Stanislaus River inflows as measured at Maze Boulevard and Airport Way, respectively. Mineral concentrations at Airport Way, the downstream study end point, were comparable to those at Lander Avenue.

The Hills Ferry Road site had the highest median EC (1710  $\mu\text{mhos}/\text{cm}$ ), boron (1.4 mg/L), chloride (240 mg/L), and sulfate (280 mg/L) values. These values are generally only slightly higher than those at Fremont Ford. Lander Avenue had the lowest median boron (0.20 mg/L) and sulfate (55 mg/L) concentrations and Airport Way had the lowest median EC (750  $\mu\text{mhos}/\text{cm}$ ) and chloride (89 mg/L) concentrations.

In order to identify possible trends in the data, EC and boron values have been plotted against time for each of the monitoring sites (Appendix C, Figures C1 and C2). The most noticeable trend in the data is that EC and boron values were generally their highest during the drier water years. EC and boron values for the critical 1987 and 1988 (first half) WYs were routinely higher than they were during the wet 1986 WY. At the Hills Ferry Road site during the wet 1986 WY, EC values ranged from 410 to 2600  $\mu\text{mhos}/\text{cm}$  with a median of 1100  $\mu\text{mhos}/\text{cm}$  (Appendix A, Table 4A). EC values increased in the critical 1987 WY to values ranging from 1600 to 2600  $\mu\text{mhos}/\text{cm}$  (Appendix A, Table 5A) with a median of 1720  $\mu\text{mhos}/\text{cm}$ . During the first half of the projected critical 1988 WY, EC values were even higher, ranging from 1380 to 2910  $\mu\text{mhos}/\text{cm}$  with a median of 2380  $\mu\text{mhos}/\text{cm}$  (Appendix A, Table 6A). Boron values followed the same trend. During the wet 1986 WY, boron values at Hills Ferry ranged from 0.29 to 2.2 mg/L with a median value of 0.91 mg/L (Appendix A, Table 4A). In the critical 1987 WY, the values ranged from 0.53 to 3.0 mg/L with a median of 1.6 mg/L (Appendix A, Table 5A) and during the first half of the projected critical 1988 WY, boron ranged from 0.57 to 3.1 mg/L with a median value of 2.1 mg/L (Appendix A, Table 6A). This trend was observed at all the monitoring sites. One possible explanation for this relationship is that during times of low streamflow, as found in critical water years, agricultural drainage water makes up a larger proportion of the San Joaquin River flow and consequently, constituents associated with this drainage water become elevated in the River.

The graphs in Appendix C also reveal seasonal variations within a given water year. To show these seasonal variations each water year has been roughly divided into the irrigation and nonirrigation seasons. For the purpose of this comparison, the irrigation season is defined to extend from April to September and the nonirrigation season from October to March. Comparing these two seasons, the nonirrigation season generally had the higher EC and boron values at each site along the river regardless of water year type. During the irrigation season surface irrigation return flows make up a large proportion of

the San Joaquin River flow and these return flows have a diluting effect on the water quality of the river. The Crows Landing site shows a steady increase in boron concentration each year after October, the nonirrigation season, regardless of water year type. Subsurface tile drainage lines are continuing to discharge boron at this time while surface irrigation return flows have ceased discharging to the river and no longer provide a diluting effect on the water quality.

Existing water quality guidelines and criteria for the protection of beneficial uses are shown in Table 2. The EC and boron values along the river do impose a slight to moderate degree of restriction on the use of river water for irrigation. Extreme EC and boron values at Fremont Ford and Hills Ferry Road have been high enough to impose severe restrictions for irrigation, but these extreme values occurred during the nonirrigation season.

### Trace Elements

All of the trace element constituents were analyzed for total recoverable concentrations. Results of water quality analysis for trace elements are listed by site in Appendix D, Table 1D. The ranges and median concentrations of the trace element constituents at each site are shown in Appendix D, Table 2D.

The ranges and median concentrations at each monitoring site are shown graphically for selenium, molybdenum, copper, chromium, nickel, and zinc in Appendix E, Figures E1 through E6, respectively. Selenium and molybdenum concentrations followed the same general trend as EC and boron along the extent of the study area. Concentrations increased at sites downstream of Salt and Mud Sloughs, and decreased at sites downstream of the Merced, Tuolumne, and Stanislaus Rivers. Copper, chromium, nickel, and zinc concentrations did not follow any noticeable trend along the river but most of the data was collected during the wet 1986 WY and is probably not a good representation of the river under normal circumstances.

The Hills Ferry Road site had the highest median selenium ( $6.6 \mu\text{g/L}$ ) and molybdenum ( $7.0 \mu\text{g/L}$ ) concentrations while Lander Avenue had the lowest median selenium ( $0.6 \mu\text{g/L}$ ) and Airport Way had the lowest median molybdenum ( $2 \mu\text{g/L}$ ) concentrations (Appendix D, Table 2D). Selenium and molybdenum concentrations at all of the monitoring sites were plotted against time in Appendix F, Figures F1 and F2. Selenium concentrations followed the same general trends observed for EC and boron with the highest concentrations occurring during the critical 1987 and 1988 WYs (Appendix F, Figure F1). Selenium values at the Hills Ferry Road site during the latter half (irrigation season) of the dry 1985 WY ranged from 1 to  $8 \mu\text{g/L}$  with a median value of  $4 \mu\text{g/L}$  (Appendix D, Table 3D). During the wet 1986 WY, selenium at this site ranged from less than 1 to  $8 \mu\text{g/L}$  with a median of  $4 \mu\text{g/L}$  (Appendix D, Table 3D). In the critical 1987 WY, concentrations increased ranging from 6.6 to  $21 \mu\text{g/L}$  with a median value of  $11 \mu\text{g/L}$  and during the first half (nonirrigation season) of the projected critical 1988 WY, selenium ranged

**Table 2. Water Quality Guidelines and Criteria for the Protection of Beneficial Uses**

Constituent	Domestic/Municipal Drinking Water			Ambient water quality criteria to protect freshwater aquatic life			Irrigation Degree of Restriction on Use			Stock Water - mg/l -
	Primary - µg/l -	Secondary - µg/l -	Other (health) - µg/l -	4 day average - µg/l - *	1 hour average - µg/l - *	None - mg/l -	Slight to Moderate - mg/l -	Severe - mg/l -		
Arsenic	50			190	360	0.1	< 0.7	0.7 - 3.0	> 3.0	0.2
Boron						0.01	0.01	0.1		5
Cadmium	10			0.55	1.4					0.05
Chromium (VI)	50			1.1	1.6					1
Copper			1000			0.1				0.5
Iron		300		5.4	7.5	0.2				
Lead (inorganic)	50			0.99	2.5	5				0.1
Mercury	2			0.012	2.4					0.01
Molybdenum						0.01				
Nickel						0.02				
Selenium	10			70	73	653				0.05
Silver	50			5	20	0.02				
Zinc			5000			0.02				
TDS (mg/l)		500 ††		49	54	2	< 450	450 - 2000	> 2000	24
EC						< 700	700 - 3000	> 3000	< 5000	< 5000

\* Acid soluble metals

†† Recommended value (Recommended level = 500 mg/l; Maximum = 1000 mg/L; Short term level = 1500 mg/l)

(References: Ayers and Westcot, 1985; EPA, 1987; EPA, 1985a; EPA, 1985b; EPA, 1980; EPA, 1979; Marshack, 1987; and SWRCB, 1987.)

from 1 to 20 µg/L with a median of 9.2 µg/L (Appendix D, Table 3D). The range and median values of selenium at Hills Ferry Road have significantly increased during the last two years. The other monitoring sites show this same trend. Also within a given water year the selenium concentrations along the river were generally higher during the nonirrigation season (October to March).

The data record for molybdenum is not as complete as it is for the other selected constituents. Most of the sites were sampled for molybdenum in 1986, but the median values at most sites were at or below the 5 µg/L detection limit. After June 1986, the detection limit was reduced to 0.1 µg/L for samples from selected sites which were sent to a laboratory that utilized a more precise analytical technique. General trends for molybdenum are not as apparent as for EC, boron, and selenium because the detection limit varied over time and by site. In order to present this data graphically, all results reported as less than the detection limit were plotted at one-quarter of the detection limit value, i.e., a laboratory reported result of less than 5 µg/L would be plotted as 1.3 µg/L. This appears to be more representative of the data than plotting less than values at the detection limit or at zero.

With the limitations of this data in mind, there does appear to be a general trend in molybdenum concentrations at Lander Avenue and Hills Ferry Road (Appendix F, Figure F2A). During the wet 1986 WY, molybdenum concentrations at Lander Avenue never exceeded 6 µg/L, but during the critical 1987 and 1988 WYs, molybdenum values ranged from 3 to 22 µg/L, with a median value of 8 µg/L (Appendix D, Table 3D). The data record for molybdenum at Lander Avenue is the most complete of all the monitoring sites.

Molybdenum concentrations at the Hills Ferry Road site ranged from 7 to 14 µg/L, with a median concentration of 11 µg/L for data collected between 18 December 1985 and 7 February 1986 (Appendix F, Figure F2C). Samples collected after the 16 February 1986 storm event ranged from 3 to 7 µg/L, with a median concentration of 4 µg/L for samples collected in the remainder of the 1986 WY. The data record is incomplete for the critical 1987 WYs but data collected between 4 November 1986 and 1 July 1987 had molybdenum concentrations ranging from less than 5 to 12 µg/L, with a median value of 7 µg/L. Data from Lander Avenue and Hills Ferry Road suggest that molybdenum concentrations follow the same general trend of increasing during dry years as did EC, boron, and selenium. More data at the lower detection limit is needed to assess seasonal variations.

Total recoverable copper, chromium, nickel, zinc, lead, and mercury were evaluated at each monitoring site in 1986. The median concentrations for these constituents do not follow any definite pattern. Hills Ferry Road and Fremont Ford generally had the highest concentrations and Lander Avenue generally had the lowest, but downstream of Hills Ferry Road the median values follow no real pattern. Median copper concentrations along the river ranged from 2 to 4 µg/L (Figure E3). Median chromium concentrations ranged from 1.5 to 6 µg/L with the highest median concentration occurring at Hills

Ferry Road (Figure E4). Median nickel concentrations ranged from below the detection limit of 5 (3.5) to 8.5 µg/L (Figure E5) and the median zinc values ranged from 4 to 12 µg/L (Figure E6).

Samples collected during the major storm event of 16 February 1986 had unusually high total recoverable nickel and chromium concentrations at the monitoring sites downstream of the Merced River confluence. The nickel, chromium, and copper concentrations at each site on this sample date are listed in Table 3. The highest concentrations for all three constituents occurred at the downstream study end point at Airport Way. The lowest concentrations occurred at Fremont Ford and Hills Ferry Road. The increase in concentrations going downstream may be due to an increase in sediment load associated with the downstream increase in stream flow due to the high volume of runoff.

Table 3. Selected Trace Element Data From  
16 February 1986 Storm Event

Index	Site	Ni	Cr - µg/L -	Cu
B	Fremont Ford	1 2	4	3
C	Hills Ferry	1 0	6	4
D	Crows Landing	3 0	2 9	4
E	Las Palmas	4 2	1 1	6
F	Laird Slough	5 4	1 3	6
G	Maze Boulevard	4 9	1 4	6
H	Airport Way	6 0	7 2	1 7

Mercury was detected on only one occasion during this period of study. It was found at 0.5 µg/L in September 1986 at Lander Avenue. All other mercury results were undetectable at a 0.5 µg/L detection limit.

The existing water quality guidelines and criteria for the protection of beneficial uses are shown in Table 2. Current EPA guidelines and criteria are based on acid-soluble trace element analyses. The more conservative total recoverable trace element analyses values utilized in this monitoring program may not be directly comparable to the acid-soluble based criteria, but reliable methods for acid-soluble analyses have not been developed to date. Total recoverable trace element data may be used as an indication of water quality compliance. Selenium, chromium, copper, and lead concentrations have exceeded these criteria.

The overall median selenium values at Fremont Ford (6.1 µg/L) and Hills Ferry Road (6.6 µg/L) exceed the EPA ambient water quality criteria of 5 µg/L for the protection of freshwater aquatic life. Selenium concentrations at these two

sites, especially in the 1987 and 1988 WYs, routinely exceed the primary drinking water standard of 10 µg/L.

Extreme total recoverable chromium values have exceeded the EPA ambient water quality criteria of 11 µg/L hexavalent chromium for the protection of fresh water aquatic life, but the median values are well below this level. Hexavalent chromium levels were not evaluated in this study. During the February 1986 storm event, chromium was found at 72 µg/L at the Airport Way site. This is above the primary drinking water criteria of 50 µg/L.

Median total recoverable copper values were all below the EPA guideline of 5.4 µg/L for the protection of freshwater aquatic life, but maximum measured copper has been as high as 17 µg/L at Airport Way.

Lead has only been detected twice (5 and 14 µg/L) and both detections occurred at the Hills Ferry Road site in late 1987. These elevated levels were not detected at later sampling dates. All other lead concentrations were undetected at a 5 µg/L detection limit. The current lead guideline for the protection of freshwater aquatic life is 0.99 µg/L. Future water quality monitoring should attempt to analyze for lead at a lower detection level.

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## **APPENDIX A**



## APPENDIX A TABLE 1A. MINERAL WATER QUALITY DATA

INDEX.A ..... MER522 SAN JOAQUIN RIVER AT LANDER AVENUE

LOCATION ..... Latitude 37°17'43", Longitude 120°51'01"  
 In NE 1/4, NE 1/4, SE 1/4, Sec. 27, T.7S., R.10E. East bank, 50 ft. W  
 of Lander Avenue (Hwy 165), 2.3 mi. S of Stevenson. River mile 132.9.

DATE	TIME	pH	EC umhos/cm	mg/L							Total	Hard.	TDS
				B	Cl	SO4	Ca	Mg	Na	K			
06/03/85	1325		390	0.10	30						27		
07/02/85	1105		1300	0.36	230						120		
08/15/85	1150		800	0.23	120						70		
08/29/85	910		600	0.08	82						52		
09/28/85	1320		192	<0.01	12						13		
10/31/85	1245		790	0.27	98						42		
12/07/85	1530		460	0.20	47						34		
12/18/85	815		670	0.23	80						64		
01/04/86	1330		930	0.61	110						190		
01/09/86	910		750	0.26	88						73		
01/14/86	1430	7.9	680	0.16	68						34		
02/07/86	1100	8.0	520	0.10	57						30		
02/17/86	855	7.9	210	0.01	11						12		
03/01/86	1650	7.9	107	<0.01	6						7		
04/19/86	1000	7.6	73	0.10	4						5		
04/26/86	1435	7.2	75	0.04	3						3		
05/13/86	1150		130	0.03	11						<5		
06/03/86	1445		190	0.05	25						23		
06/16/86	1615		230	<0.01	20						16		
06/26/86	1300		510	0.14	65						52		
08/04/86	1505		460	0.11	50						32		
09/02/86	1120		340	0.06	28						22		
09/27/86	1430		140	0.10	7						8		
												26	37
												26	56
												30	370
												120	390
												60	150
												20	51
												24	77
												36	34
												26	26
												30	30
												40	40

## INDEX A .....MEE522 SAN JOAQUIN RIVER AT LANDER AVENUE (cont.)

DATE	TIME	pH	EC umhos/cm	B	Cl	SO4	Ca	Mg	Na	K	CO3	HCO3	Total mg/L	Alk.	Hard.	TDS
11/04/86	725	7.9		0.16	69	46							130			
12/04/86	1440			0.21	130	14	45	16	150	6.5	0	240	240	160	580	
01/02/87	1100			0.25	62	72							0	120	140	140
01/30/87	1055			0.28	82	68							0	120	120	120
02/27/87	1100			0.20	150											
04/01/87	1280			0.21	230											
05/01/87	1650			0.35	300											
06/01/87	1300			1000	0.16	146	75									
06/15/87	1250			1220	0.10	200										
07/01/87	1140			1200	0.25	170										
07/15/87	1220			1400	0.31	250										
07/31/87	1240			1200	0.28	170	110						160			
08/17/87	1420			1240	0.31	190	100						160			
09/01/87	1245			790	0.20	100	55						150			
09/18/87	1120			713	0.18	80	47						160			
10/01/87	1235			357	0.04	24	13						100			
10/15/87	1010			318	0.03	28	13						80			
11/03/87	1215			1150	0.19	180	68						2	260	262	
11/17/87	1210			1504	0.27	220	82						0	290	290	
12/01/87	1315			940	0.26	150	71						0	120	120	
12/14/87	1130			1080	0.26	150	90						0	180	180	
01/05/88	1245			1150	0.47	110	150						0	180	180	
01/15/88	1100			910	0.24	98	64						0	190	190	
01/27/88	1750			1000	0.16	130	62						0	210	210	
02/16/88	1155			1200	0.33	170	120						0	200	200	
03/02/88	1130			1700	0.30	270	120						0	280	280	
03/09/88	1230			1150	0.20	160	94						0	220	220	

## APPENDIX A TABLE 1A. MINERAL WATER QUALITY DATA.

INDEX.B ..... MER538 SAN JOAQUIN RIVER AT FREMONT FORD

LOCATION ..... Latitude 37°18'34", Longitude 120°55'45"  
 In NW 1/4, NW 1/4, SE 1/4, Sec. 24, T.7S., R.9E.  
 West bank at Fremont Ford State Recreation Area, 50 ft. S of Hwy 140,  
 5.4 mi. NE of Gustine. River mile 125.1.

DATE	TIME	pH	EC umhos/cm	mg/L						Total	Alk.	Hard.	TDS
				B	Cl	SO <sub>4</sub>	Ca	Mg	Na				
05/02/85	1445		1900	1.2	260	829							
06/03/85	1340		1100	1.0	99	210							
07/02/85	1120		1200	0.98	160	210							
08/14/85	1830		1200	0.87	180	200							
08/29/85	925		1000	0.58	150	150							
09/28/85	1335		640	0.33	87	66							
10/30/85	1700		1440	0.88	220	253							
12/07/85	1545		1530	1.3	200	260							
12/18/85	840		2200	1.4	350	360							
01/04/86	1355		1950	1.1	340	340							
01/09/86	955		2300	1.8	300	440				0	180		
01/14/86	1410		1800	1.7	250	370							
02/07/86	1115	8.1	1600	1.5	190	350	91	37	193	4.6	0	140	390
02/16/86	1525	7.9	730	0.42	81	110	34	17	74	5.2	0	96	1000
03/02/86	1630	8.9	220	0.13	17	24	11	6	19	2.6	12	32	420
04/19/86	1015	7.5	94	0.09	6	7	6	2	8	1.1	0	26	50
04/26/86	1400	7.1	230	0.10	26	32	13	5	20	1.8	0	36	140
05/13/86	1215		340	0.12	39	40							
06/03/86	1420		350	0.27	44	130							
06/16/86	1555		590	0.12	66	95							
06/26/86	1245		870	0.53	110	120							
08/04/86	1435		940	0.77	120	160							
09/02/86	1100		1000	0.86	110	160							
09/27/86	1405		570	0.44	69	120							

## APPENDIX...A

TABLE...1A  
.....MER538 SAN JOAQUIN RIVER AT FREMONT FORD (cont.)

DATE	TIME	pH	EC units/cm	B	Cl	SO <sub>4</sub>	Ca	Mg	Na	K	CO <sub>3</sub>	HCO <sub>3</sub>	Total	Alk.	Hard.	TDS
11/04/86	745	7.7		0.81	150	210	320	110	45	240	11	0	160	160	400	200
12/04/86	1425			1.6	240	420										
01/02/87	1045			1.9	260	420										
01/30/87	1045			2.4	260	420										
02/27/87	1045			2880	3.2	430										
04/01/87	1045			2190	1.9	960										
05/01/87	1205			1680	1.3	260										
06/01/87	1245			1590	1.5	206										
07/01/87	1155			1800	2.1	220										
07/15/87	1200			1700	1.6	250										
07/31/87	1255			1500	1.2	170										
08/17/87	1405			1610	1.0	220										
09/01/87	1300			1330	0.88	190										
09/18/87	1100			1760	1.3	240										
10/01/87	1250			1640	1.1	240										
10/15/87	955			1260	0.41	180										
11/03/87	1200			1850	1.9	280										
11/17/87	1140			1966	1.7	290										
12/01/87	1300			2340	1.8	320										
12/14/87	1110			2870	2.3	420										
01/05/88	1230			2950	2.6	390										
01/15/88	1020			2850	2.7	390										
01/28/88	1310			2850	2.1	410										
02/16/88	1135			2700	2.8	360										
03/02/88	1115			2100	1.9	260										
03/09/88	1215			2150	1.8	280										

## APPENDIX A TABLE 1A. MINERAL WATER QUALITY DATA

INDEX.C ..... STC512 SAN JOAQUIN RIVER SOUTH OF HILLS FERRY ROAD

LOCATION ..... Latitude 37°20'33", Longitude 120°58'38"  
 In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T.7S., R.9E.  
 West bank, 0.9 mi. SE of Hills Ferry Road at abandoned tallow factory,  
 immediately upstream of Merced River inflow, 3.3 mi. NE of Newman. River mile 118.8.

DATE	TIME	pH	EC µmhos/cm	mg/L							Total	Alk.	Hard.	TDS
				B	Cl	SO <sub>4</sub>	Ca	Mg	Na	K				
05/02/85	1525			2200	1.6	290	520							
06/03/85	1430			1300	1.2	130	270							
07/02/85	1345			1450	1.2	180	310							
08/14/85	1600			1350	0.98	190	210							
08/29/85	1145			1200	0.90	170	210							
09/27/85	1720			730	0.45	87	100							
10/30/85	1445			1520	1.1	230	239							
12/18/85	1015			2400	2.1	400	410							
01/03/86	1635			2500	1.9	370	480							
01/09/86	1120			2600	2.2	360	480							
01/14/86	1045			2400	1.8	320	430							
02/01/86	1205			2200	2.2	330	490							
02/07/86	1240			8.3	1950	1.7	240	430	33	49	252	5.6	0	1600
02/16/86	1215			8.2	1100	0.82	120	160	45	25	131	5.9	0	1200
03/01/86	1245			8.1	560	0.49	72	93	22	14	59	3.8	0	670
04/19/86	1050			7.7	420	0.39	40	62	19	9	46	1.8	0	330
04/26/86	1105			7.4	410	0.29	56	74	22	10	43	2.2	0	110
05/12/86	1645			8.1	570	0.32	63	88	27	12	82	2.2	0	240
06/03/86	1050			7.8	700	0.68	42	68	40	12	87	3.5	0	440
06/16/86	1515			890	0.55	100	160							350
06/26/86	1000			1100	1.1	140	200	71	25	130	4.2	0	200	700
08/04/86	1115			1200	1.0	130	210							250

## INDEX C .....STC512 SAN JOAQUIN RIVER SOUTH OF HILLS FERRY ROAD (cont.)

DATE	TIME	pH	EC µhos/cm	B	Cl	SO4	Ca	Mg	Na	K	CO3	HCO3	Total mg/L	Alk.	Hard.	TDS
09/02/86	1210		1020	0.81	120	160							120 <sup>†</sup>			
09/27/86	1045		640	0.41	62	120							92 <sup>b</sup>			
11/04/86	9035			0.53	180	250							160 <sup>c</sup>			
12/04/86		7.6	2200	1.1	170	210	73	37	220	8.4	0	140	140 <sup>d</sup>	280 <sup>e</sup>	870	
01/02/87	1105			2.0	330	480							210	200	470	1500
01/30/87	930	7.9	2200	2.5	280	390	120	48	280	7.7	0	200	220	530	1950	
02/27/87	920	8.1	2600	3.0	450	800	120	55	330	7.7	0	180	180	440	1390	
05/01/87	1030	7.7				450	100	46	220	7.7	0					
06/01/87	1130	8.1	1710	1.6	227	218	82	45	155	11.0	0	176	176	373	1084	
06/15/87	1030	8.2		2.2		460	61	54	222	7.8	0					
07/01/87	1315	7.9	1600	1.7	190	280	100	40	200	6.2	0	160	160	414	970	
07/15/87	1112	7.8	1700	1.7	260	300	97	40	210	6.1	0	160	160	407	1000	
07/31/87	1335	8.1	1700	1.4	180	280	110	43	200	6.2	0	160	160	370	1000	
08/17/87	1325	7.9	1930	1.5	240	400	89	42	230	6.2	0					
09/01/87	1400	8.1	1610	1.3	220	280	78	36	200	6.4	0	160	160	340	960	
09/18/87	1030	8.0	1730	1.3	240	280	78	40	230	5.8	0	180	180	340	1000	
10/01/87	1350	7.7	1710	1.1	240	240	77	41	230	5.8	0	170	170	330	1000	
10/15/87	915	7.9	1380	0.57	190	180	55	34	190	5.5	0					
11/03/87	1050	7.6	1700	1.4	260	260	65	32	210	7.8	0	190	190	330	1000	
11/17/87	1040	7.9	2150	1.6	300	340	89	55	250	6.7	0	200	200	410	1300	
12/01/87	1145	7.7	2370	1.7	370	410	99	69	330	8.2	0	190	190	460	1400	
12/14/87	1030	8.1	2830	2.2	420	480	110	74	380	7.1	0	250	250	510		
01/05/88	1010	8.1	2780			390	510	110	73	380	6.9	0	240	240	540	
01/15/88	1215	7.9	2910	2.5	390	600	130	76	380	7.1	0	260	260	570		
01/28/88	1235	7.9	2800	2.1	390	460	110	68	350	9.0	0	260	260	520		
02/16/88	1055	8.1	2850	2.8	390	600	150	71	400	5.6	0	220	220	590	1800	
02/19/88	1645	8.0	3100	3.1	430	680	160	85	450	6.2	0	220	220	660	2100	
03/02/88	1025	8.2	2300	2.0	320	450	120	61	290	6.1	0	180	180	480	1400	
03/09/88	1055	8.0	2380	2.1	310	495	120	63	32	5.5	0	195	195	520	1500	

## APPENDIX A TABLE 1A. MINERAL WATER QUALITY DATA.

INDEX.D ..... STC504 SAN JOAQUIN RIVER AT CROWS LANDING ROAD

LOCATION ..... Latitude 37° 25' 55", Longitude 121° 00' 42"  
 In SW 1/4, NW 1/4, NW 1/4, Sec. 8, T. 6S., R. 3E.  
 West bank, 100 yds S of Crows Landing Road Bridge, 4.2 mi. NE  
 of Crows Landing. River mile 107.2.

DATE	TIME	pH	EC umhos/cm	B	Cl	SO <sub>4</sub>	Ca	Mg	Na	K	CO <sub>3</sub>	HCO <sub>3</sub>	Total	Alk.	Hard.	TDS
05/02/85	1545		1200	0.70	160		221									
06/03/85	1455		940	0.80	77		180									
07/02/85	1410		1000	0.85	120		170									
08/14/85	1530		1050	0.77	140		140									
08/29/85	1200		990	0.57	140		150									
09/27/85	1700		630	0.27	85		79									
10/30/85	1415		950	0.61	130		144									
12/18/85	1045		1600	1.2	250		22									
01/03/86	1610		1560	1.2	230		320									
01/09/86	1150		1700	1.2	210		280									
01/14/86	1020		1700	0.69	240		340									
02/01/86	1140	8.2	1600	1.2	210		260	75	40	206	6.8	0	180	180	330	850
02/07/86	1300	8.2	1250	1.0	150		260	66	34	164	5.0	0	140	140	300	800
02/16/86	1155	8.0	750	0.44	53		130	36	20	83	5.4	0	110	110	170	450
03/02/86	1220	7.9	480	0.33	49		64	19	11	46	3.6	0	62	62	86	240
04/19/86	1115	7.7	290	0.18	37		31	11	5	32	1.5	0			64	180
04/26/86	1045	7.4	270	0.14	30		46	15	6	28	1.7	0	40	40	280	160
05/12/86	1610		340	0.27	35		55									40
06/03/86	1020		440	0.38	48		100									60
06/16/86	1450		600	0.15	67		98									100
06/26/86	930		930	0.68	110		140									120
08/04/86	1055		850	0.61	97		130									80
09/02/86	1145		780	0.56	89		120									100

## INDEX.D .....STC504 SAN JOAQUIN RIVER AT CROWS LANDING ROAD (cont.)

DATE	TIME	pH	EC umhos/cm	B	Cl	SO4	Ca	Mg	Na	K	CO3	HCO3	Total mg/L.....	Alk.	Hard.	TDS
09/27/86	1025	500	0.27	53	64								80			
11/04/86	1000		0.67	130	140								120			
12/04/86		7.6	0.82	120	160	55	29	150	7.8	0	130	130	240	150	150	700
01/02/87	1045		1400	1.0	210	270										
01/30/87	910		1400	1.4	150	230						0	150			
02/27/87	900		1990	1.9	290											
04/01/87	905		1950	1.7	300											
05/01/87	1015		1320	0.77	180											
06/01/87	1100		1210	0.89	166	180										
06/15/87	1005		1480	1.2	186	292										
07/01/87	1330		1200	1.0	150											
07/15/87	1050		1400	1.1	220											
07/31/87	1405		1300	0.89	150	190								150		
08/17/87	1300		1270	0.94	160	180										
09/01/87	1420		1200	0.79	160	180										
09/18/87	1005		1220	0.70	180	160										
10/01/87	1410		1180	0.61	160	150										
10/15/87	900		1190	0.46	150	120										
11/03/87	1030		1400	1.0	220	200										
11/17/87	1020		1252	0.79	170	190										
12/01/87	1120		1420	0.89	190	240										
12/14/87	1010		1680	1.1	210	260										
01/05/88	1055		1700	1.2	220	280										
01/15/88	1250		1980	1.6	240	380										
01/28/88	1215		1850	1.4	240	300										
02/16/88	1030		1950	1.6	250	380										
02/19/88	1615		2000	1.7	250	400										
03/02/88	1000		1750	1.4	230	300										
03/09/88	1040		1750	1.4	240							0	150	150	170	

## APPENDIX A TABLE 1A. MINERAL WATER QUALITY DATA.

INDEX.E ..... STC507 SAN JOAQUIN RIVER NORTH OF LAS PALMAS AVENUE (Patterson Bridge)

DATE	TIME	pH	EC umhos/cm	B	Cl	SO4	Ca	Mg	Na	K	CO3	HCO3	Total	Alk.	Hard.	TDS
.....mg/L.....																
05/02/85	1615		1200	0.70	150		220									
06/03/85	1515		1050	0.85	93		200									
07/02/85	1445		1100	0.86	140		110									
08/14/85	1505		1050	0.53	130		140									
08/29/85	1230		890	0.47	120		130									
09/27/85	1640		640	0.26	82		73									
10/30/85	1330		920	0.59	130		148									
12/18/85	1115		1540	1.2	250		220									
01/03/86	1545		1520	1.2	230		300									
01/09/86	1225		1700	1.1	210		270									
01/14/86	955		1800	1.7	220		310									
02/01/86	1120	8.3	1500	1.3	220		270	76	38	202	6.8		170	170	340	960
02/07/86	1325	8.2	1200	1.0	150		230	104	31	156	5.6		140	140	280	790
02/16/86	1135	8.1	750	0.48	71		85	35	19	83	5.5		0	110	110	420
03/01/86	1200	7.7	430	0.32	48		57	18	11	41	3.6		0	62	62	240
04/19/86	1220	7.6	240	0.29	24		30	11	5	23	1.5		0		56	140
04/26/86	1025	7.3	280	0.15	31		44	15	7	27	1.8		0	40	40	300
05/12/86	1540	7.7	370	0.18	37		49	18	8	44	1.7		0	50	50	240
06/03/86	1000	7.4	470	0.34	52		76	27	12	54	2.7		0	70	70	110
06/16/86	1430		600	0.11	70		96							100	100	250
06/26/86	915	8.2	870	0.60	100		130	52	19	93	3.6		0	200	200	190
08/04/86	1030		870	0.53	96		120								130	
09/02/86	1125		910	0.59	100		140								120	
09/27/86	1000		570	0.25	64		71								100	

## INDEX.E ..... STC507 SAN JOAQUIN RIVER NORTH OF LAS PALMAS AVENUE (cont.)

DATE	TIME	pH	EC umhos/cm	B	Cl	SO4	Ca	Mg	Na	K	CO3	HCO3	Total mg/L	Alk.	Hard.	TDS
11/04/86	1025	7.7		0.70	130	140							130			
12/04/86	1025	7.7		0.79	140	170	56	30	150	7.8	0	140	140	260	730	
01/02/87	1025		1400	0.95	210	250								160		
01/30/87	855			1200	1.1	130	210						0	130	130	
02/27/87	845			1960	1.8	280										
04/01/87	840			1860	1.6	270										
05/01/87	1000			1360	0.70	190										
06/01/87	1055			1290	0.85	181	210									
07/01/87	1355			1300	0.95	160										
07/31/87	1435			1400	1.0	150	200									
09/01/87	1450			1230	0.77	160	180									
10/01/87	1430			1230	0.64	180	120									
11/03/87	1015			1400		210	200									
12/01/87	1050			1430	0.81	200	190									
01/05/88	1040			1700	1.1	220	260									
01/28/88	1150			1900	1.4	250	340									
02/19/88	1555			1900	1.5	250	360									
03/09/88	1020			1600	1.3	230	320									
													0	170	170	

APPENDIX A TABLE 1A. MINERAL WATER QUALITY DATA.

INDEX F ..... STC511 SAN JOAQUIN RIVER AT GRAYSON ROAD (LAIRD SLOUGH)

LOCATION ..... Latitude 37°33'45", Longitude 121°09'03"  
 In NW 1/4, SE 1/4, NW 1/4, Sec. 25, T.4S., R.7E.  
 Laird Park, 500 ft S of Grayson Road Bridge, 1.5 mi. E of Grayson.  
 River mile 89.1.

DATE	TIME	pH	EC μmhos/cm	mg/L						Total	Alk.	Hard.	TDS
				B	Cl	S04	Ca	Mg	Na				
06/03/85	1540		1000	0.78	93		170						
07/02/85	1510		1000	0.76	120		160						
08/14/85	1435		1050	0.45	170		160						
08/29/85	1255		890	0.48	130		120						
09/27/85	1610		690	0.38	94		76						
10/30/85	1305		970	0.56	130		119						
12/18/85	1240		1560	0.58	240		240						
01/03/86	1515		1560	1.1	230		290						
01/09/86	1320		1600	1.1	210		270						
01/14/86	930		1700	1.2	230		320						
02/01/86	1040	8.2	1400	1.1	200	260	74	36	190	7.4	0	160	190
02/07/86	1400	8.2	1300	1.2	150	220	68	31	157	7.5	0	140	320
02/16/86	1110	8.0	600	0.42	47	80	29	20	74	5.9	0	120	275
03/01/86	1125	8.0	430	0.30	45	54	19	10	43	3.9	0	54	770
04/26/86	1000	7.3	280	0.17	32	45	14	6	28	1.9	0	43	43
06/03/86	930		440	0.32	53	78							60
06/26/86	845		960	0.81	120	150							120
08/04/86	1010		870	0.57	100	120							110
09/02/86	1055		850	0.55	99	120							120
09/27/86	930		570	0.21	50	59							96
11/04/86	1050		0.59	140	140								140
12/04/86	1615		7.7	0.75	110	140	55	32	170	7.2	0	160	260
01/02/87	1000		1400	0.95	220	250							170
01/30/87	830		1400	1.2	130	150							160

INDEX.F .....STC511 SAN JOAQUIN RIVER AT GRAYSON ROAD (LAIRD SLOUGH) (cont.)

02/27/87	825	1890	1.6	270
04/01/87	820	1760	1.4	240
05/01/87	935	1220	0.62	160
06/01/87	1035	1260	0.88	151
07/01/87	1420	1200	0.97	150
07/31/87	1500	1300	0.76	150
09/01/87	1515	1240	0.73	180
10/01/87	1445	1300	0.66	190
11/03/87	955	1350	0.93	210
12/01/87	1030	1490	0.76	190
01/05/88	1015	1700	1.0	220
01/28/88	1125	1900	1.4	250
03/09/88	1000	1700	1.3	320

## APPENDIX A

## TABLE 1A. MINERAL WATER QUALITY DATA.

INDEX.G ..... STC510 SAN JOAQUIN RIVER AT MAZE BLVD. (Hwy 132)

LOCATION ..... Latitude 37°38'31", Longitude 121°13'40"  
 In SW 1/4, NW 1/4, SW 1/4, Sec. 29, T.3S., R.7E.  
 West bank, 400 ft S of Maze Blvd. Bridge, upstream of Blewett Drain,  
 5.7 mi. NW of Grayson. River mile 77.3.

DATE	TIME	pH	EC umhos/cm	B	Cl	SO <sub>4</sub>	Ca	Mg	Na	K	CO <sub>3</sub>	HCO <sub>3</sub>	Total	Alk.	Hard	TDS	
05/02/85	1705	900	0.40	110	137												
06/03/85	1605	820	0.60	71	130												
07/02/85	1535	900	0.52	120	110												
08/14/85	1410	900	0.46	120	120												
08/29/85	1325	800	0.36	100	110												
09/27/85	1535	620	0.25	80	59												
10/30/85	1230	700	0.43	98	84												
12/18/85	1320	1110	0.66	160	100												
01/03/86	1455	1040	0.65	140	180												
01/09/86	1550	870	0.54	110	130												
01/14/86	905	1100	0.70	150	170												
02/01/86	1015	8.2	940	0.60	120	150	47	23	107	4.4	0	100	100	200	580		
02/07/86	1430	8.1	730	0.51	90	120	40	20	86	4.4	0	96	96	160	430		
02/16/86	1045	7.9	580	0.19	60	92	27	16	57	6.0	0	92	92	140	360		
03/01/86	1100	7.9	300	0.22	30	33	13	8	28	2.8	0	46	46	57	190		
04/19/86	1250	7.6	200	0.14	15	20	11	5	19	1.5	0			48	130		
04/26/86	930	7.2	250	0.13	29	34	14	7	24	1.9	0	41	41	300	130		
05/12/86	1500		280	0.15	30	42									40		
06/03/86	915		290	0.17	33	48									40		
06/16/86	1400		330	0.15	42	44									70		
06/26/86	830		730	0.47	98	110									110		
08/04/86	1000		710	0.39	79	92									120		
09/27/86	910		410	0.13	28	32									68		
11/04/86	1115		0.35	74	66										76		

## INDEX.G .....STC510 SAN JOAQUIN RIVER AT MAZE BLVD. (HWY 132) (cont.)

DATE	TIME	pH	EC umhos/cm	B	Cl	SO4	Ca	Mg	Na	K	CO3	HCO3	Total mg/L	Alk.	Hard	TDS
12/04/86	1630	7.5		0.31	50	64	18	12	58	3.3	0	69	69	100	280	
01/02/87	935		490	0.30	65									65		
01/30/87	805		780	0.64	95	110								98	98	
02/27/87	805		1420	1.1	200											
04/01/87	800		1280	0.92	160											
05/01/87	915		728	0.37	94											
06/01/87	1010		961	0.57	136	125										
07/01/87	1440		1200	0.91	140									150		
07/31/87	1525		1100	0.72	130	150								150		
09/01/87	1540		1120	0.68	150	160										
10/01/87	1510		1010	0.48	140	110								150		
11/03/87	935		1100	0.64	160	130								140		
12/01/87	1005		1110	0.54	150	140								140		
01/05/88	955		1350	0.74	160	180								150		
01/28/88	1100		1600	1.1	190	230								180		
02/19/88	1105		1550	1.1	180	240								160		
03/09/88	945		1400	1.0	170	240								150		

## APPENDIX A TABLE 1A. MINERAL WATER QUALITY DATA.

INDEX.H ..... SJ501 SAN JOAQUIN RIVER AT AIRPORT WAY

LOCATION ..... Latitude 37°40'32", Longitude 121°15'51"  
 In SE 1/4, SW 1/4, NW 1/4, Sec. 13, T.3S., R.6E.  
 West bank, 50 ft S of Airport Way Bridge; 3.2 mi. NE of Vernalis.  
 River mile 73.6.

DATE	TIME	pH	EC μmhos/cm	mg/L							Total	Alk.	Hard.	TDS
				B	Cl	S04	Ca	Mg	Na	K				
05/02/85	1725	680	0.20	83	99									
06/03/85	1625	640	0.45	71	86									
07/02/85	1555	510	0.30	64	67									
08/14/85	1345	480	0.23	61	60									
08/29/85	1325	540	0.23	70	67									
09/27/85	1515	540	0.31	65	52									
10/30/85	1155	590	0.18	76	65									
12/18/85	1345	980	0.54	140	100									
01/03/86	1430		0.51	120	160									
01/09/86	1605	750	0.41	93	100									
01/14/86	840	940	0.70	110	160									
02/01/86	950	8.1	810	0.60	98	130	40	19	89	4.2	0	90	170	510
02/07/86	1445	7.9	600	0.38	73	110	32	16	66	4.9	0	88	150	350
02/16/86	1025	7.9	520	38	57	24	14	48	5.3	0	88	88	120	300
03/02/86	1040	7.9	260	0.18	29	34	13	7	24	2.9	0	48	60	150
04/19/86	1315	7.6	180	0.13	16	39	10	4	18	1.4	0	40	40	130
04/26/86	915	7.2	250	0.12	29	38	15	7	24	1.9	0	44	44	320
05/12/86	1430	7.9	290	0.15	24	33	14	6	30	1.5	0	40	40	150
06/03/86	850	7.8	270	0.21	21	38	16	8	28	1.9	0	40	40	130
06/16/86	1330		290	0.10	30	37								
06/26/86	800	7.9	560	0.31	64	71	33	13	52	2.6	0	140	120	330
08/04/86	935		520	0.24	58	62							80	
09/02/86	1000		480	0.22	52	58							80	

## INDEX H .....SJC501 SAN JOAQUIN RIVER AT AIRPORT WAY (cont.)

DATE	TIME	pH	EC umhos/cm	B	Cl	SO4	Ca	Mg	Na	K	CO3	HCO3	Total Alk.	Hard.	TDS
09/27/86	850	730	0.13	22	24								56		
11/04/86	1130		0.26	59	57								73	62	
12/04/86	1650	7.5	0.25	18	25								53		
01/02/87	915		0.18	40	48								86		
01/30/87	750		0.43	81	95								86		
02/27/87	745		0.59	110											
04/01/87	745		0.55	100											
05/01/87	900		0.25	64											
06/01/87	1000		0.39	86											
06/15/87	920		0.30	91											
07/01/87	1500		0.55	90											
07/15/87	1000		0.62	120											
07/31/87	1540		0.54	90											
08/17/87	950		0.52	120											
09/01/87	1610		0.47	100											
09/18/87	915		0.40	100											
10/01/87	1535		0.38	110											
10/15/87	810		0.28	88											
11/03/87	920		0.56	140											
11/17/87	945		0.47	120											
12/01/87	940		0.44	130											
12/14/87	930		0.56	140											
01/05/88	935		0.62	140											
01/15/88	1330		0.80	160											
01/28/88	1045		0.94	170											
02/16/88	940		0.95	160											
02/19/88	1000		0.94	170											
03/02/88	930		0.64	110											
03/09/88	925		0.58	110											
				900									0	100	

**APPENDIX A**

TABLE 2A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM MAY 1985 TO MARCH 1988

		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY RD.	FREMONT FORD	LANDER AVENUE
<b>EC</b> ( $\mu$ mhos/cm)	Minimum	180	200	280	240	270	410	94	73
	Median	750	900	1260	1215	1251	1710	1625	770
	Maximum	1450	1600	1900	1960	2000	3100	2950	1700
	# Samples	(49)	(39)	(35)	(40)	(50)	(47)	(48)	(48)
<b>B</b> (mg/L)	Minimum	0.1	0.13	0.17	0.11	0.14	0.29	0.09	<0.01
	Median	0.40	0.51	0.76	0.80	0.84	1.4	1.3	0.20
	Maximum	0.95	1.1	1.6	1.8	1.9	3.1	3.2	0.61
	# Samples	(51)	(41)	(37)	(41)	(52)	(49)	(50)	(50)
<b>Cl</b> (mg/L)	Minimum	16	15	32	24	30	40	3	3.1
	Median	89	110	150	150	160	240	230	93
	Maximum	170	200	270	280	300	450	960	300
	# Samples	(52)	(41)	(37)	(42)	(52)	(49)	(50)	(50)
<b>SO4</b> (mg/L)	Minimum	24	20	45	30	22	62	7	3
	Median	86	110	170	175	180	280	260	55
	Maximum	220	240	320	360	400	800	829	190
	# Samples	(47)	(36)	(33)	(38)	(46)	(51)	(45)	(45)
<b>Ca</b> (mg/L)	Minimum	10	11	14	11	11	19	6.4	3.8
	Median	17	18	42	31	36	78	23	12
	Maximum	40	47	74	104	75	160	110	45
	# Samples	(10)	(7)	(6)	(10)	(7)	(34)	(6)	(7)
<b>Mg</b> (mg/L)	Minimum	4	5	6	5	5	9	2	1
	Median	10	12	26	16	20	44	12	7
	Maximum	19	23	36	38	40	85	45	19
	# Samples	(10)	(7)	(6)	(10)	(7)	(34)	(6)	(7)

**APPENDIX A**

TABLE 2A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM MAY 1985 TO MARCH 1988 (CONTINUED)

		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY RD.	FREMONT FORD	LANDER AVENUE
<b>Na</b> (mg/L)	# Samples	Minimum 3.8 Median 8.9 Maximum (10)	1.8 5.7 107 (7)	1.9 116 190 (6)	2.8 6.9 202 (10)	2.3 5.0 206 (7)	2.8 8.3 221 (34)	4.3 450 (6)	8 240 (6)
<b>K</b> (mg/L)	# Samples	Minimum 2.8 Median 5.3 Maximum (10)	1.4 3.3 6.0 (7)	1.5 6.5 7.5 (6)	1.9 3.6 7.8 (10)	1.5 5.0 7.8 (7)	1.5 6.2 11.0 (33)	1.8 3.6 11.0 (6)	1.1 3.1 6.5 (7)
<b>Tot. Alk.</b> (mg/L)	# Samples	Minimum 110 Median 160 Maximum (34)	4.0 100 180 (23)	4.0 160 200 (26)	4.3 145 200 (34)	4.0 150 190 (34)	4.9 180 260 (38)	2.6 150 230 (33)	2.0 130 290 (33)
<b>Hardness</b> (mg/L)	# Samples	Minimum 107 Median 320 Maximum (10)	4.0 140 300 (7)	4.8 268 340 (6)	8.4 180 340 (10)	5.6 240 330 (7)	6.4 410 330 (33)	9.2 118 660 (6)	2.4 4.7 400 (6)
<b>TDS</b> (mg/L)	# Samples	Minimum 130 Median 195 Maximum (10)	130 280 580 (7)	160 580 850 (6)	140 335 960 (10)	160 450 850 (7)	240 1000 2100 (30)	6.6 170 1000 (6)	3.7 150 580 (7)

**APPENDIX A**

**TABLE 3A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM THE 1985 DRY WATER YEAR  
(MAY 1985 - SEPTEMBER 1985)**

		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
<b>EC</b> ( $\mu$ mhos/cm)	Minimum	4.80	6.20	6.90	6.40	6.30	7.30	6.40	19.2
	Median	5.40	8.60	10.00	10.50	9.95	13.25	11.50	7.00
	Maximum	6.80	9.00	10.50	12.00	12.00	22.00	19.00	13.00
	# Samples	(6)	(5)	(6)	(6)	(6)	(6)	(6)	(5)
<b>B</b> (mg/L)	Minimum	0.20	0.25	0.38	0.26	0.27	0.45	0.33	<0.01
	Median	0.27	0.43	0.48	0.62	0.64	1.10	0.93	0.10
	Maximum	0.45	0.60	0.78	0.86	0.85	1.60	1.20	0.36
	# Samples	(6)	(6)	(5)	(6)	(6)	(6)	(6)	(5)
<b>C1</b> (mg/L)	Minimum	6.1	7.1	9.3	8.2	7.7	8.7	8.7	1.2
	Median	6.8	10.5	12.0	12.5	13.0	15.0	15.5	8.2
	Maximum	8.3	12.0	17.0	15.0	16.0	29.0	26.0	23.0
	# Samples	(6)	(6)	(5)	(6)	(6)	(6)	(6)	(5)
<b>SO4</b> (mg/L)	Minimum	5.2	5.9	7.6	7.3	7.9	10.0	6.6	1.3
	Median	6.7	11.5	16.0	13.5	16.0	24.0	20.5	5.2
	Maximum	9.9	13.7	17.0	22.0	22.1	52.0	82.9	12.0
	# Samples	(6)	(6)	(5)	(6)	(6)	(6)	(6)	(5)

## APPENDIX A

TABLE 4A . SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM THE 1986 WET WATER YEAR

	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC ( $\mu\text{mhos}/\text{cm}$ )	Minimum 180 Median 540 Maximum 980 # Samples (18)	200 700 1100 (17)	280 960 1700 (15)	240 870 1800 (18)	270 815 1700 (18)	410 1100 2600 (18)	94 905 2300 (18)	73 400 930 (18)
B (mg/L)	Minimum 0.10 Median 0.22 Maximum 0.7 # Samples (17)	0.13 0.39 0.70 (17)	0.17 0.57 1.2 (15)	0.11 0.56 1.7 (18)	0.14 0.59 1.2 (18)	0.29 0.91 2.2 (18)	0.09 0.65 1.8 (18)	<0.1 0.10 0.61 (18)
Cl (mg/L)	Minimum 16 Median 55 Maximum 140 # Samples (18)	15 79 160 (17)	32 120 240 (15)	24 98 250 (18)	30 93 250 (18)	40 125 400 (18)	6 110 350 (18)	3 38 110 (18)
SO <sub>4</sub> (mg/L)	Minimum 24 Median 60 Maximum 160 # Samples (18)	20 92 180 (17)	45 120 320 (15)	30 125 310 (18)	22 125 340 (18)	62 180 490 (18)	7 145 440 (18)	2.7 (<5.0) 38 190 (18)
Ca (mg/L)	Minimum 10 Median 16 Maximum 40 # Samples (9)	11 21 47 (6)	14 29 74 (5)	11 27 104 (9)	11 28 75 (6)	19 33 120 (9)	6 33 91 (5)	4 13 91 (6)
Mg (mg/L)	Minimum 4 Median 8 Maximum 19 # Samples (9)	5 12 23 (6)	6 20 36 (5)	5 12 38 (9)	5 16 40 (6)	9 14 60 (9)	2 6 37 (5)	1 6 19 (6)

## APPENDIX A

TABLE 4A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM 1986 WET WATER YEAR (Continued)

	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Na (mg/L)	Minimum 30 Median 89 Maximum 107 # Samples (9)	18 4.3 (6)	19 74 (5)	28 54 (9)	23 202 (6)	28 65 (9)	43 206 (9)	8 87 20 193 (5)
K (mg/L)	Minimum 2.6 Median 5.3 Maximum 6.8 # Samples (9)	1.4 3.6 (6)	1.5 5.9 (5)	1.9 3.6 (9)	1.5 4.3 (6)	1.5 4.3 (9)	1.8 3.8 2.6 5.2 (5)	1.1 2.7 2.7 5.5 (6)
TOTALK (mg/L)	Minimum 80 Median 140 Maximum 140 # Samples (13)	40 81 (12)	40 120 (11)	43 115 (12)	40 100 (13)	40 118 (14)	49 230 (13)	20 96 180 150 (13)
HARDNESS (mg/L)	Minimum 120 Median 320 Maximum 300 # Samples (9)	40 150 (6)	48 275 (5)	84 170 (9)	56 340 (6)	64 330 (6)	92 510 (9)	24 56 390 160 (5)
TDS (mg/L)	Minimum 130 Median 160 Maximum 510 # Samples (9)	130 275 580 (6)	160 430 850 (5)	140 250 960 (9)	160 345 850 (6)	240 350 1600 (9)	66 140 1000 (5)	37 114 390 (6)

## APPENDIX A

TABLE 5A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM THE 1987 CRITICAL WATER YEAR

		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC ( $\mu$ mhos/cm)	Minimum	340	490	1200	1200	0.67	1600	1330	650
	Median	804	1100	1300	1360	0.94	1720	1730	1200
	Maximum	930	1420	1890	1960	1.8	2600	2880	1650
	# Samples	(13)	(9)	(9)	(9)	(15)	(10)	(12)	(13)
B (mg/L)	Minimum	0.18	0.30	0.59	0.70	0.53	0.81	0.10	0.21
	Median	0.43	0.64	0.88	0.95	1.6	1.6	0.21	0.35
	Maximum	0.62	1.1	1.6	1.8	3	3.2	(15)	(15)
	# Samples	(15)	(11)	(11)	(11)	(15)	(13)	(14)	
Cl (mg/L)	Minimum	18	50	110	130	120	170	150	62
	Median	90	130	151	160	166	235	250	170
	Maximum	120	200	270	280	300	450	960	300
	# Samples	(15)	(11)	(11)	(11)	(15)	(12)	(14)	(15)
SO4 (mg/L)	Minimum	25	64	140	140	140	210	200	14
	Median	85	118	180	200	180	290	280	70
	Maximum	120	160	250	250	292	800	420	111
	# Samples	(10)	(6)	(7)	(7)	(10)	(14)	(9)	(10)
Ca (mg/L)	Minimum						61		
	Median						93		
	Maximum						120		
	# Samples						(12)		
Mg (mg/L)	Minimum						36		
	Median						43		
	Maximum						55		
	# Samples						(12)		

## APPENDIX A

TABLE 5A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM THE 1987 CRITICAL WATER YEAR (CONTINUED)

		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Na (mg/L)	# Samples	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
K (mg/L)	# Samples	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median
TOT ALK (mg/L)	# Samples	53	65	87	140	130	120	140	130
HARDNESS (mg/L)	# Samples	103	103	120	150	145	150	176	160
TDS (mg/L)	# Samples	120	120	(8)	170	160	160	220	240

**APPENDIX A**

TABLE 6A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM THE 1988 CRITICAL WATER YEAR  
 (OCTOBER 1987 - MARCH 1988)

		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
<b>EC</b> ( $\mu$ mhos/cm)	Minimum	747	1010	1300	1230	1180	1380	1260	318
	Median	1000	1350	1595	1600	1750	2380	2250	1120
	Maximum	1450	1600	1900	1900	2000	2910	2950	1700
	# Samples	(13)	(7)	(6)	(7)	(13)	(13)	(12)	(12)
<b>B</b> (mg/L)	Minimum	0.28	0.48	0.66	0.64	0.46	0.57	0.41	0.03
	Median	0.58	0.74	0.97	1.3	1.2	2.1	1.9	0.25
	Maximum	0.95	1.1	1.4	3	1.7	3.1	2.8	0.47
	# Samples	(13)	(7)	(6)	(7)	(13)	(12)	(12)	(12)
<b>Cl</b> (mg/L)	Minimum	8.8	14.0	19.0	18.0	15.0	19.0	18.0	2.4
	Median	14.0	16.0	21.5	22.0	22.0	37.0	31.0	15.0
	Maximum	17.0	19.0	25.0	25.0	25.0	43.0	42.0	27.0
	# Samples	(13)	(7)	(6)	(7)	(13)	(13)	(12)	(12)
<b>SO4</b> (mg/L)	Minimum	73	110	170	120	120	180	150	13
	Median	140	180	225	260	280	480	430	77
	Maximum	220	240	320	360	400	680	660	150
	# Samples	(13)	(7)	(6)	(7)	(12)	(13)	(12)	(12)
<b>TOT ALK</b> (mg/L)	Minimum	100	140	160	150	140	160	140	80
	Median	130	150	170	160	160	200	180	200
	Maximum	160	180	200	190	180	260	230	290
	# Samples	(13)	(7)	(6)	(7)	(13)	(13)	(12)	(12)
<b>Ca</b> (mg/L)	Minimum						55		
	Median						110		
	Maximum						160		
	# Samples						(13)		

**APPENDIX A**

TABLE 6A. SUMMARY OF SELECTED MINERAL WATER QUALITY DATA FROM THE 1988 CRITICAL WATER YEAR  
 (OCTOBER 1987 - MARCH 1988) (CONTINUED)

	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
<b>Mg</b> (mg/L)	Minimum Median Maximum # Samples					3.2 6.8 8.5 (13)		
<b>Na</b> (mg/L)	Minimum Median Maximum # Samples					32 (190) 340 450 (12)		
<b>K</b> (mg/L)	Minimum Median Maximum # Samples					5.5 6.7 9.0 (13)		
<b>HARDNESS</b> (mg/L)	Minimum Median Maximum # Samples					260 510 660 (13)		
<b>TDS</b> (mg/L)	Minimum Median Maximum # Samples					820 1400 2100 (9)		



## APPENDIX B



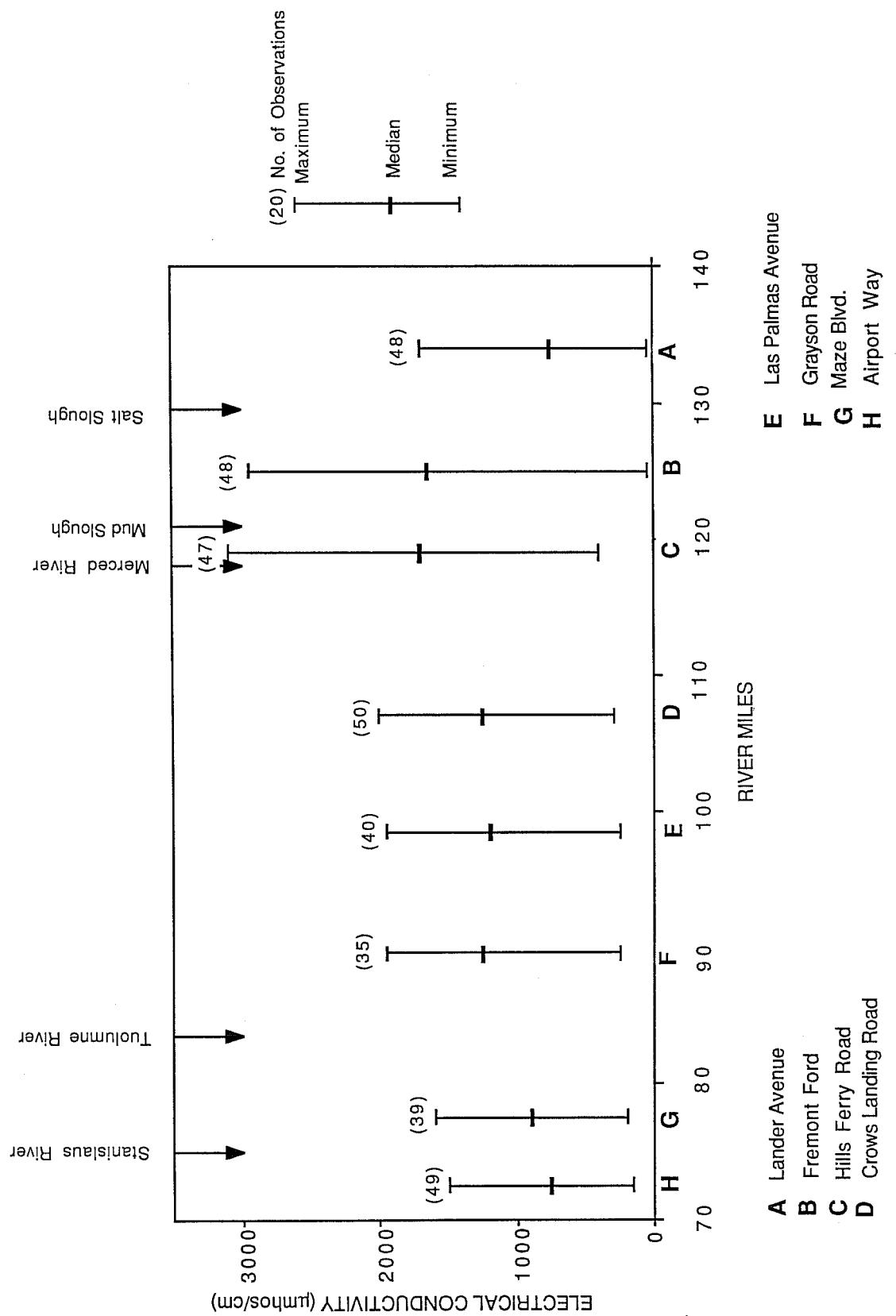


Fig. B1. San Joaquin River Electrical Conductivity Measurements

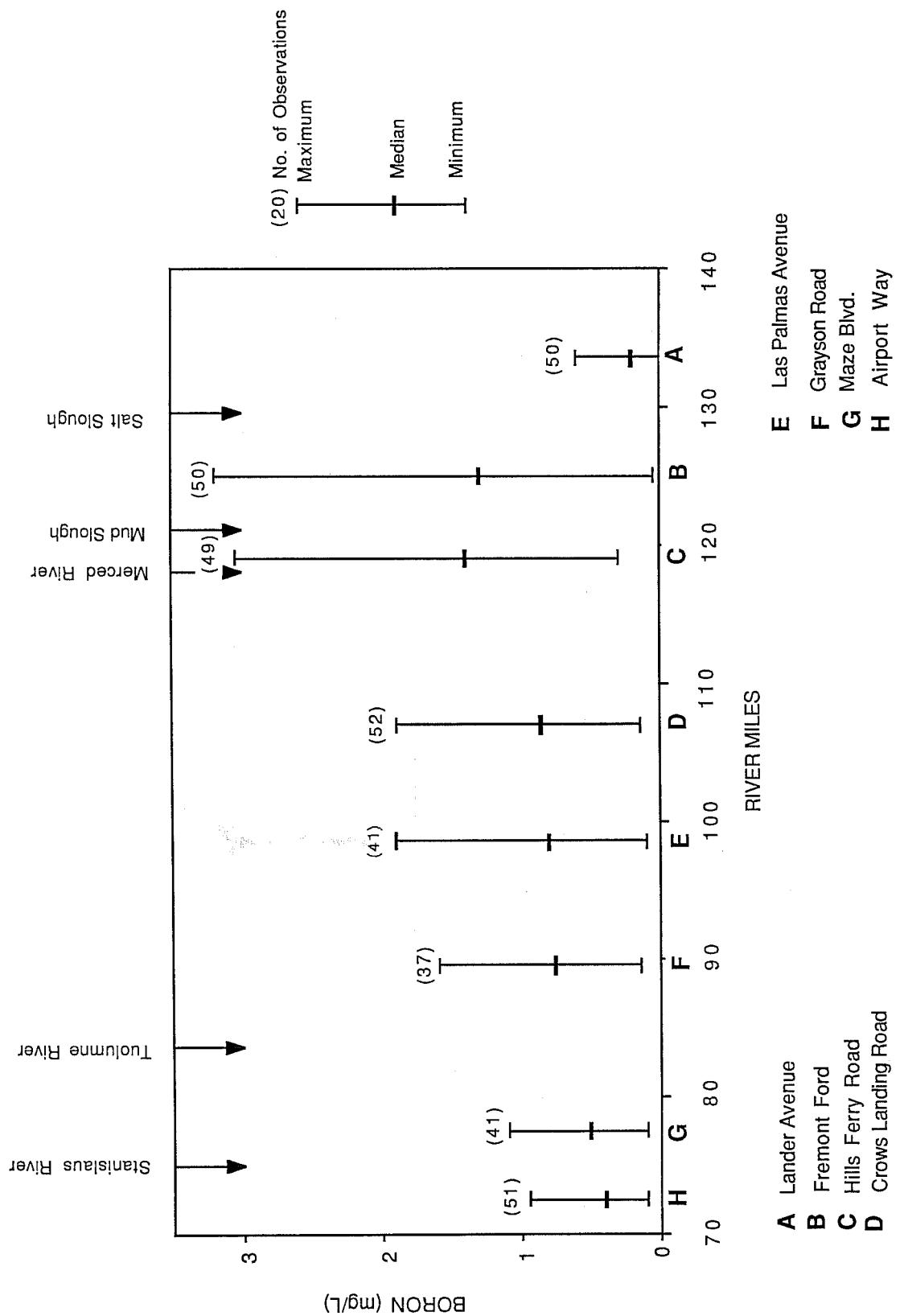


Fig. B2. San Joaquin River Boron Concentrations

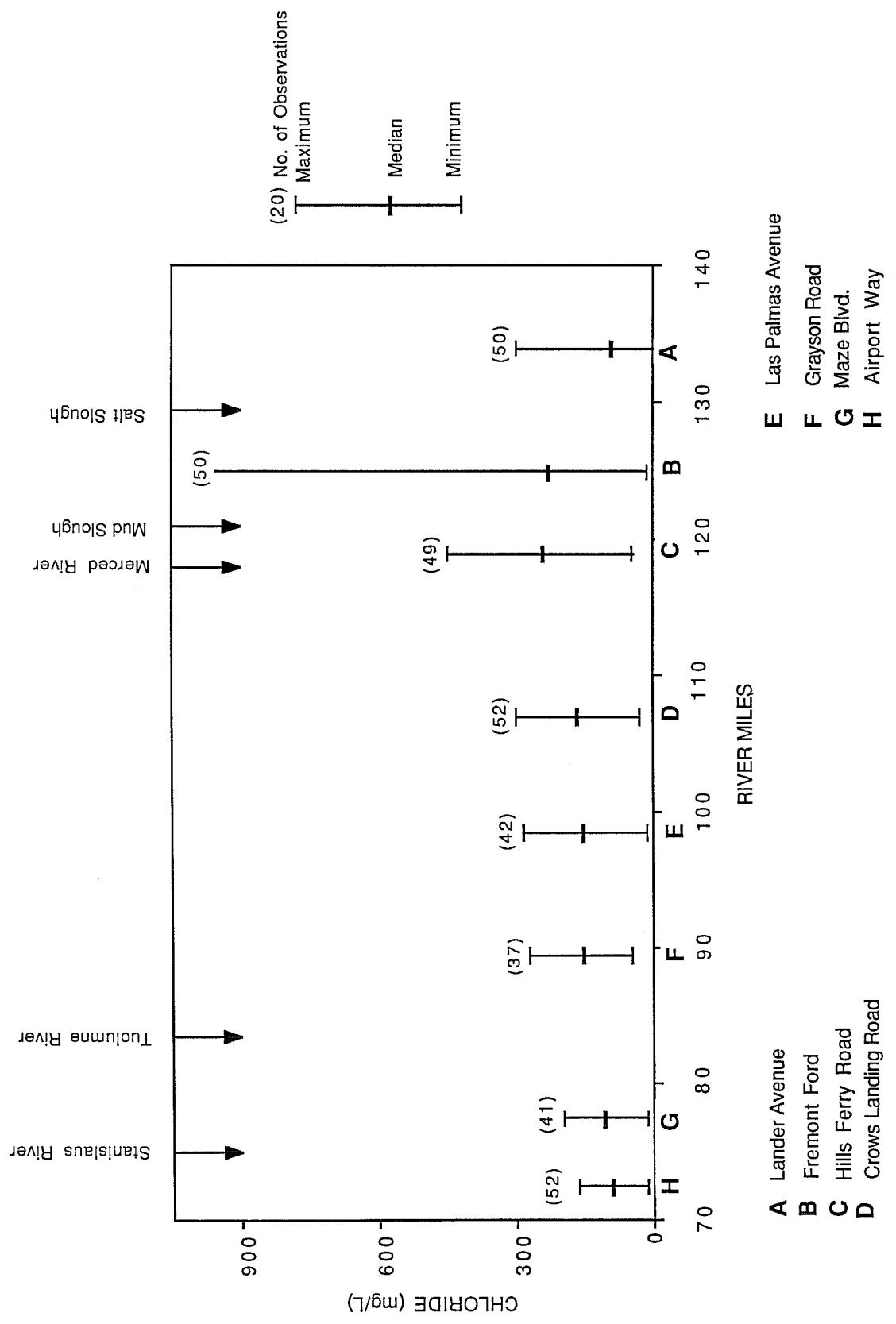


Fig. B3. San Joaquin River Chloride Concentrations

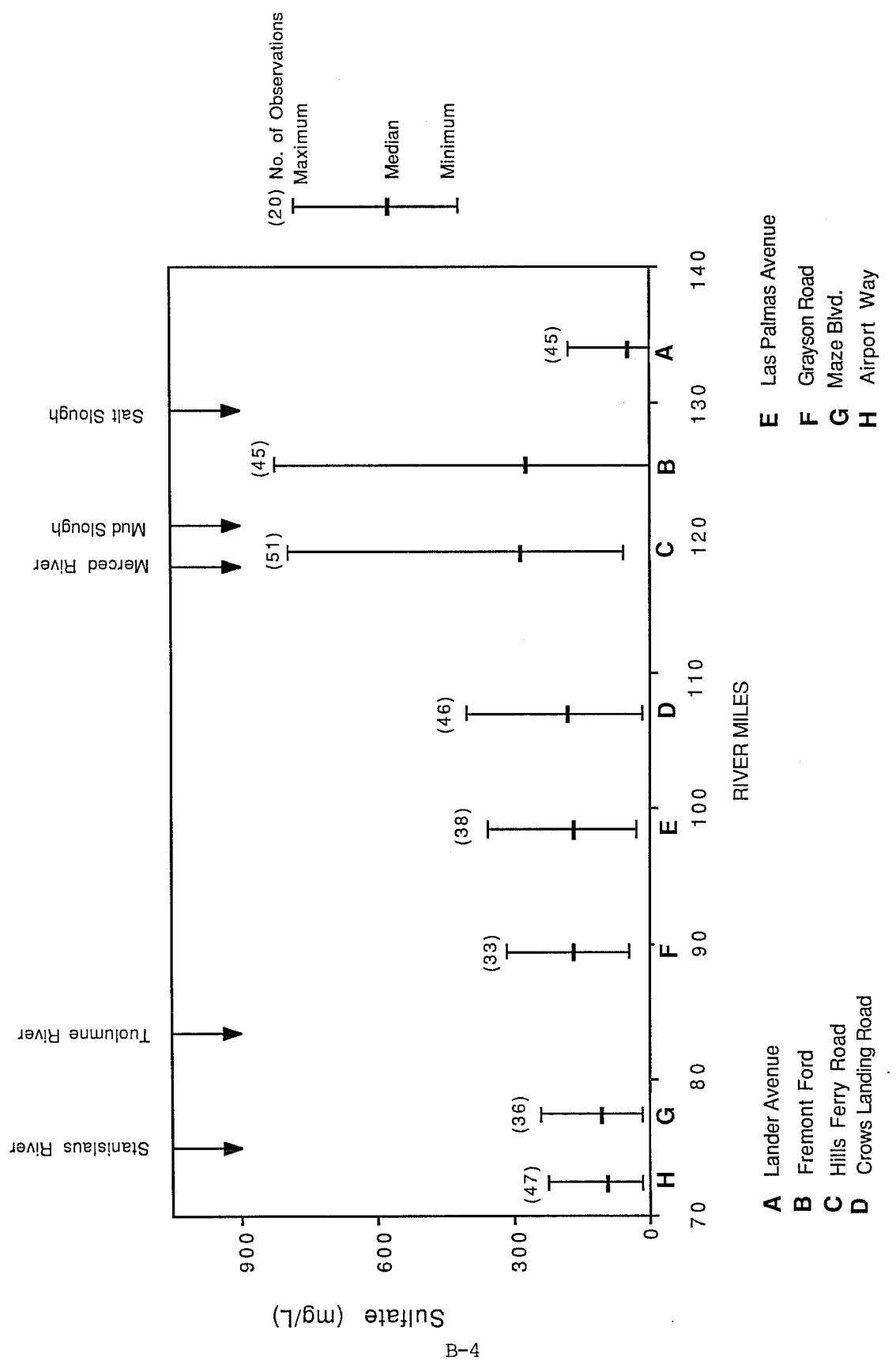


Fig. B4. San Joaquin River Sulfate Concentrations

## APPENDIX C



## ELECTRICAL CONDUCTIVITY vs. TIME

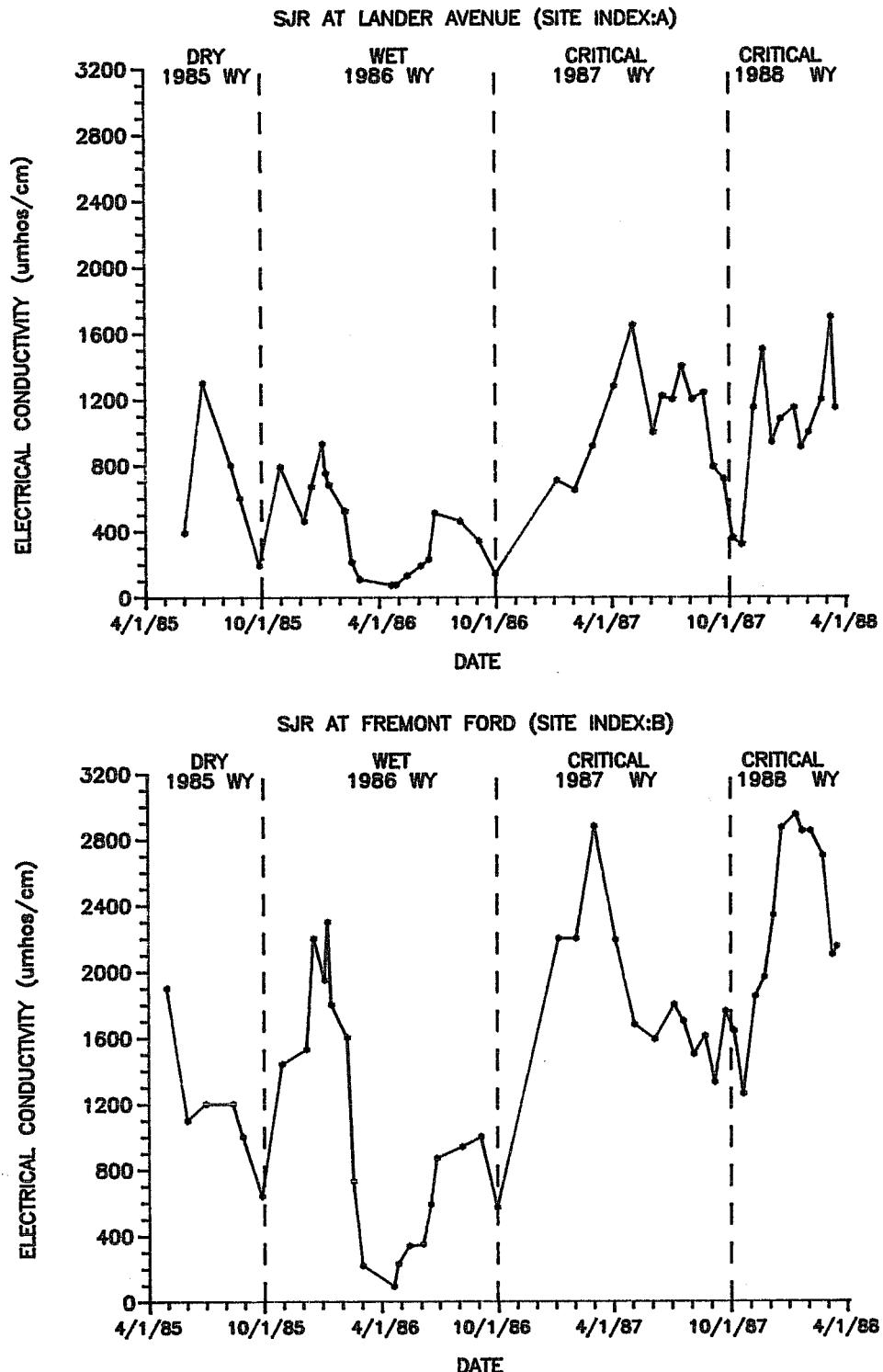


Fig. C1. EC vs. time at each monitoring site.

## ELECTRICAL CONDUCTIVITY vs. TIME

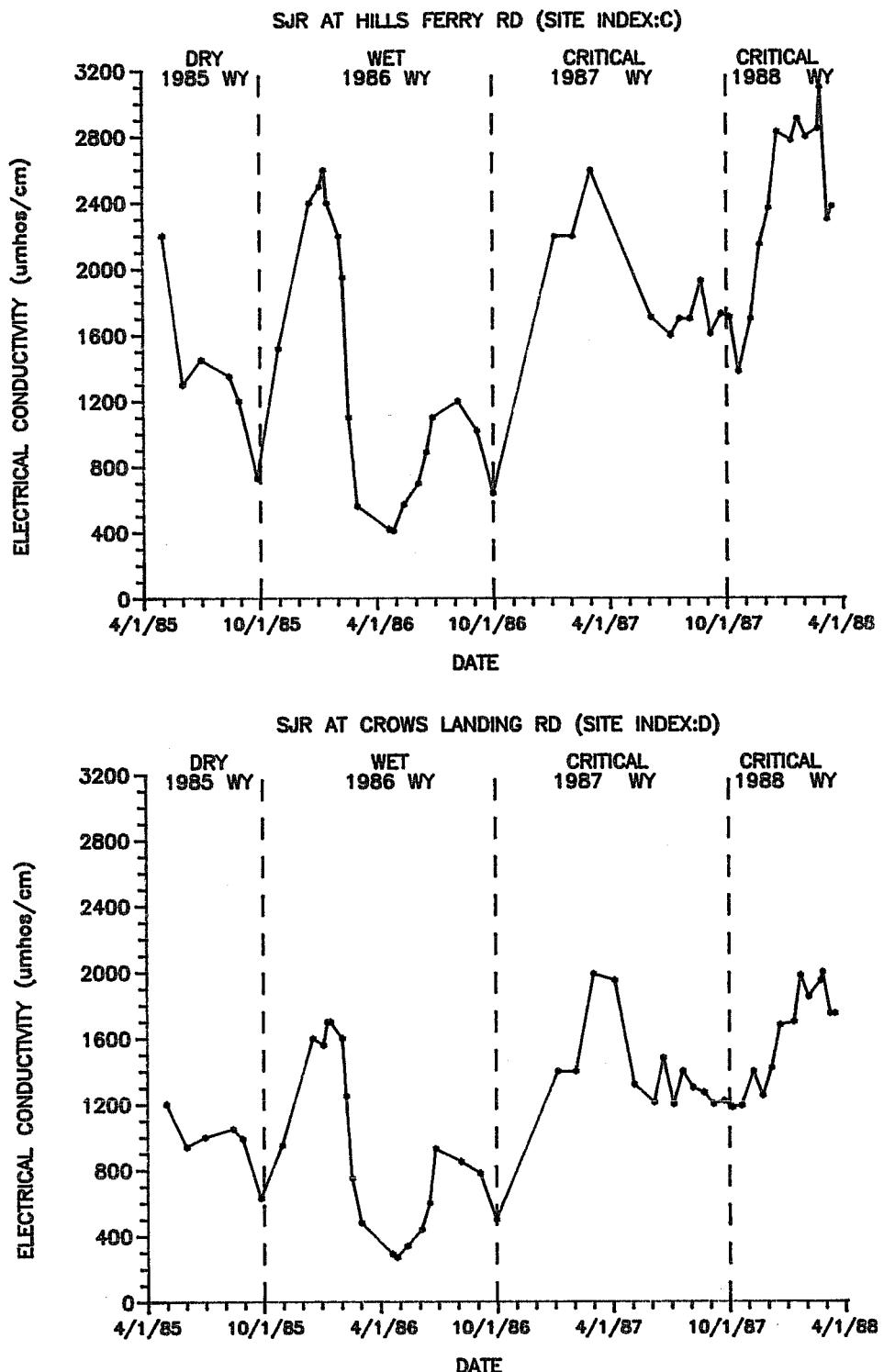


Fig. C1. EC vs. time at each monitoring site (cont.).

## ELECTRICAL CONDUCTIVITY vs. TIME

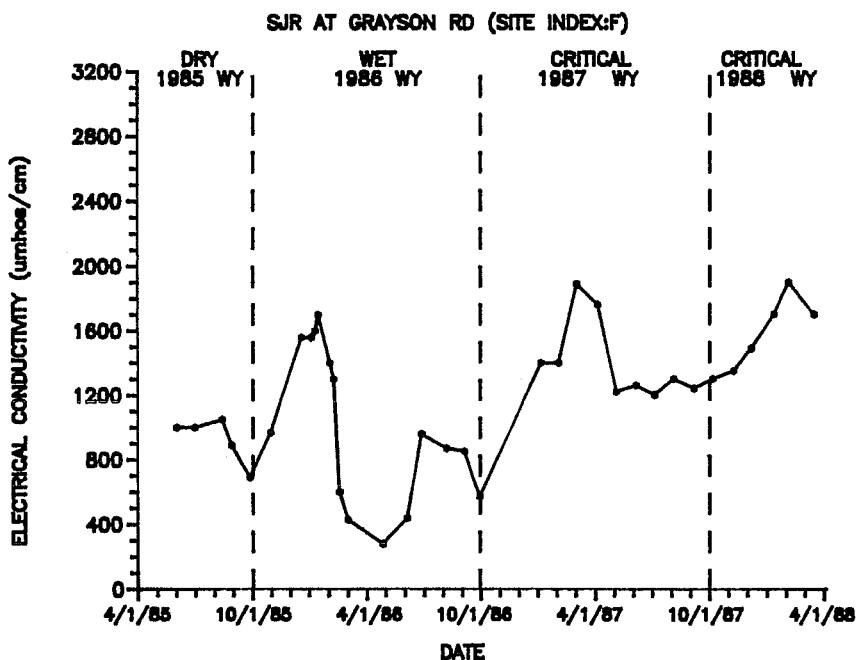
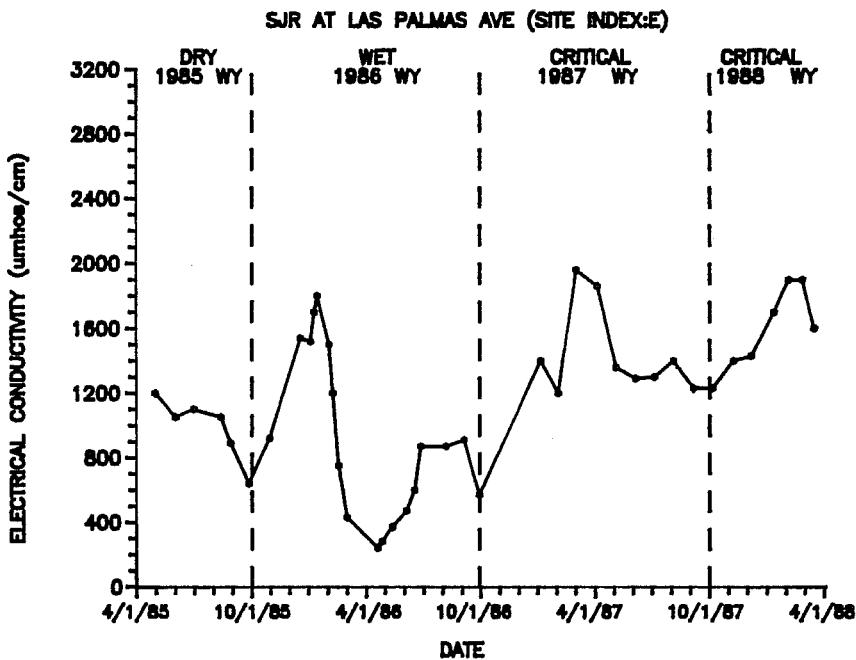


Fig. C1. EC vs. time at each monitoring site (cont.).

## ELECTRICAL CONDUCTIVITY vs. TIME

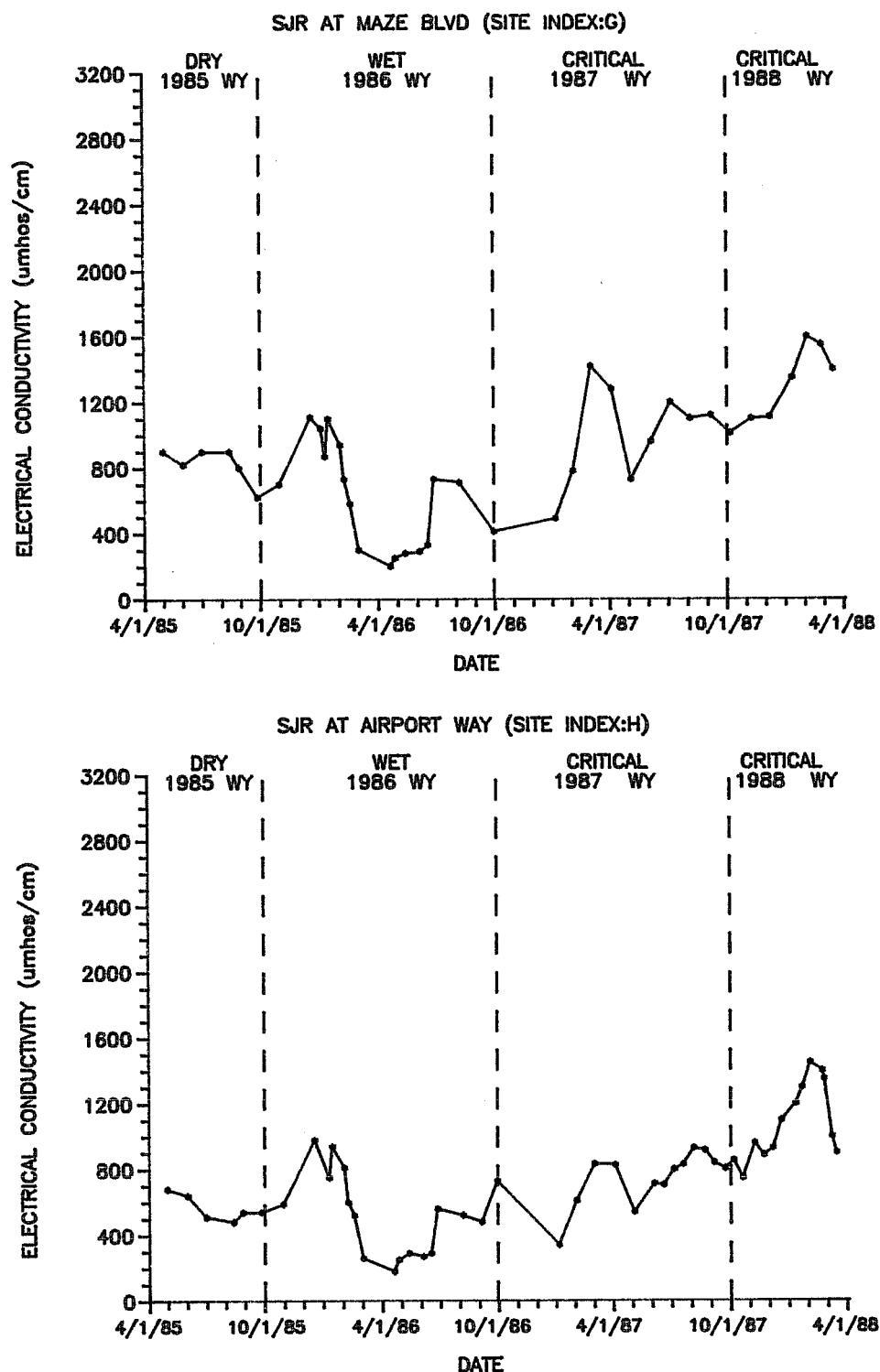


Fig. C1. EC vs. time at each monitoring site (cont.).

## BORON vs. TIME

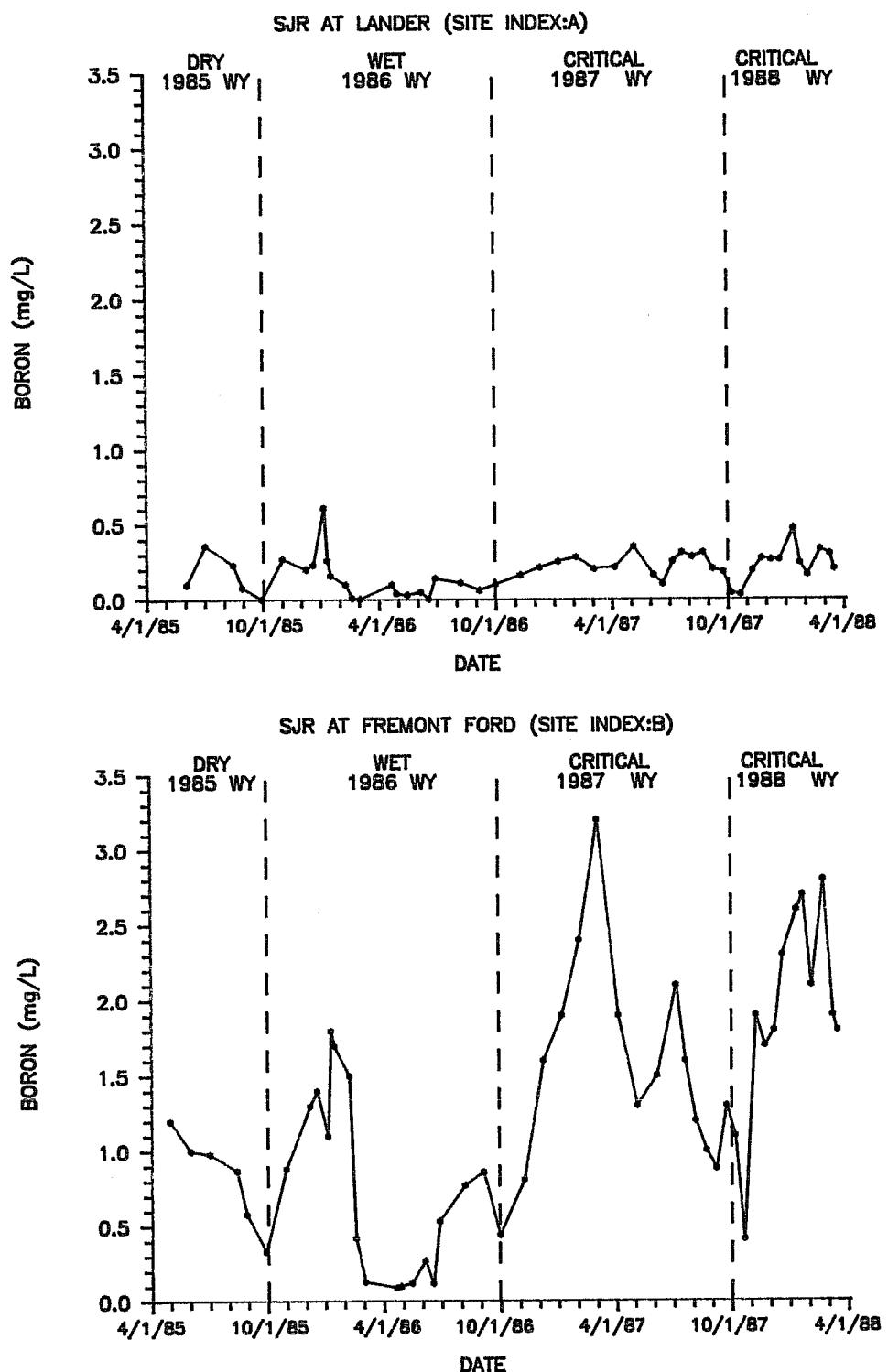


Fig. C2. Boron vs. time at each monitoring site.

## BORON vs. TIME

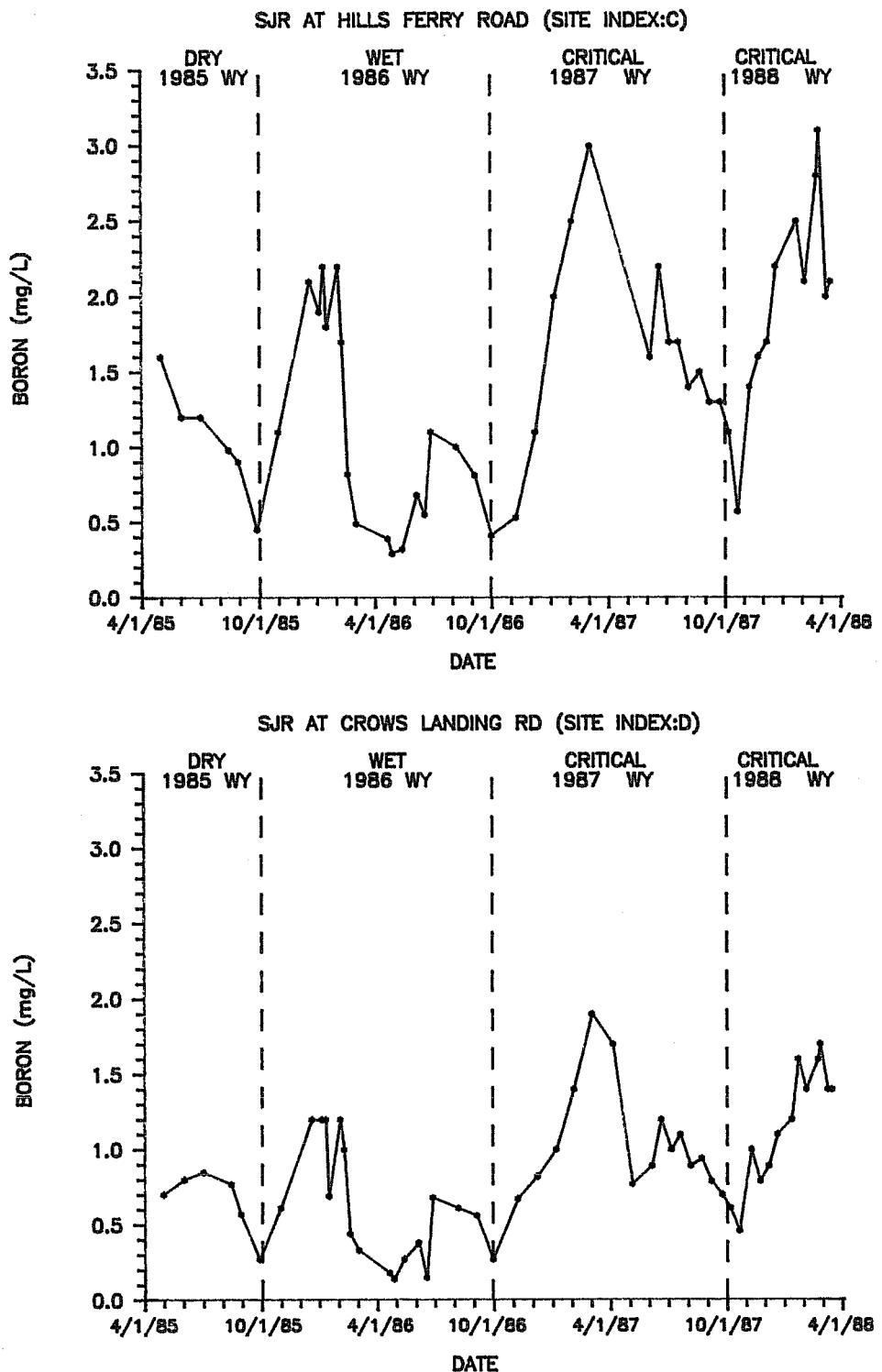


Fig. C2. Boron vs. time at each monitoring site (cont.).

### BORON vs. TIME

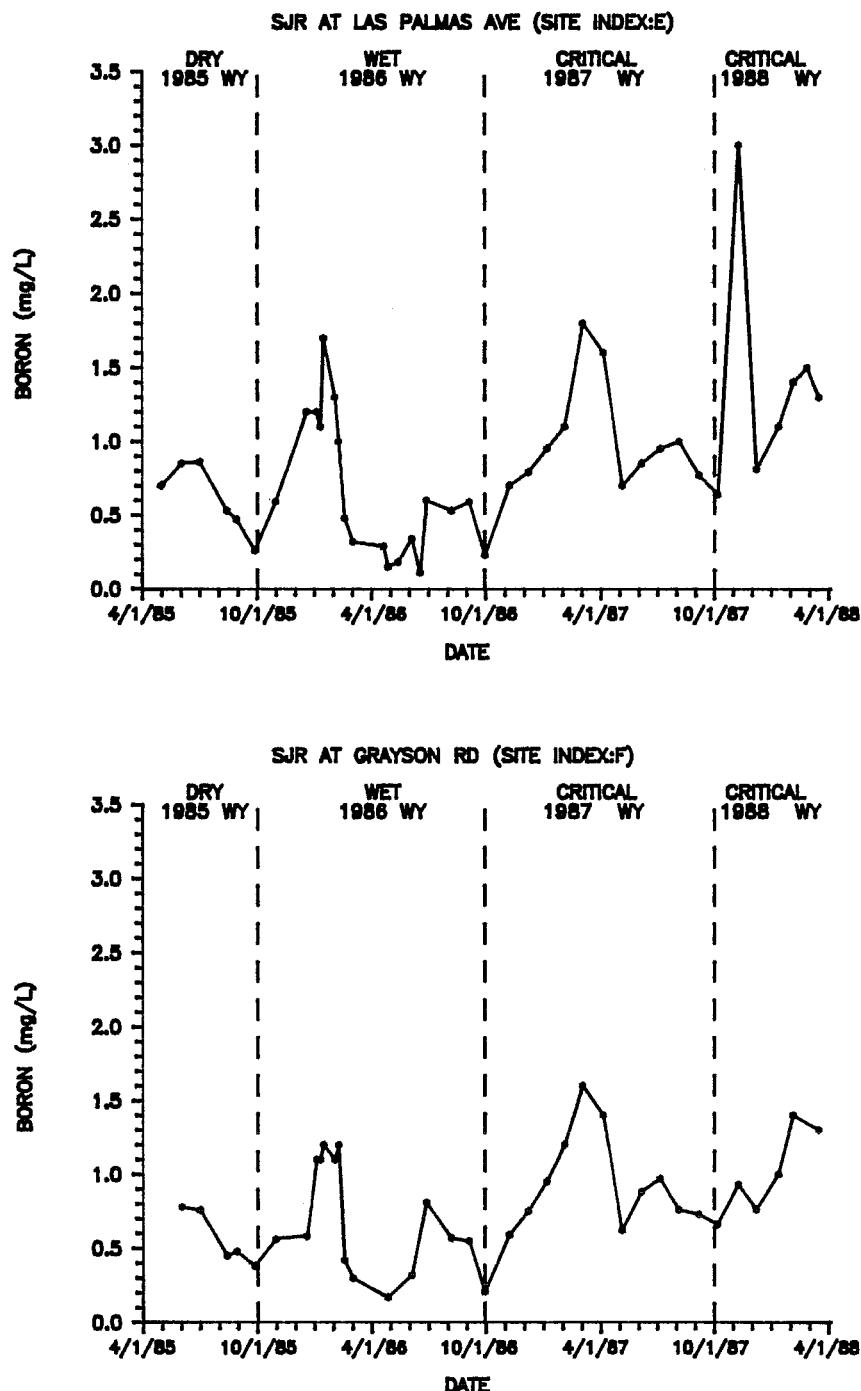


Fig. C2. Boron vs. time at each monitoring site (cont.).

## BORON vs. TIME

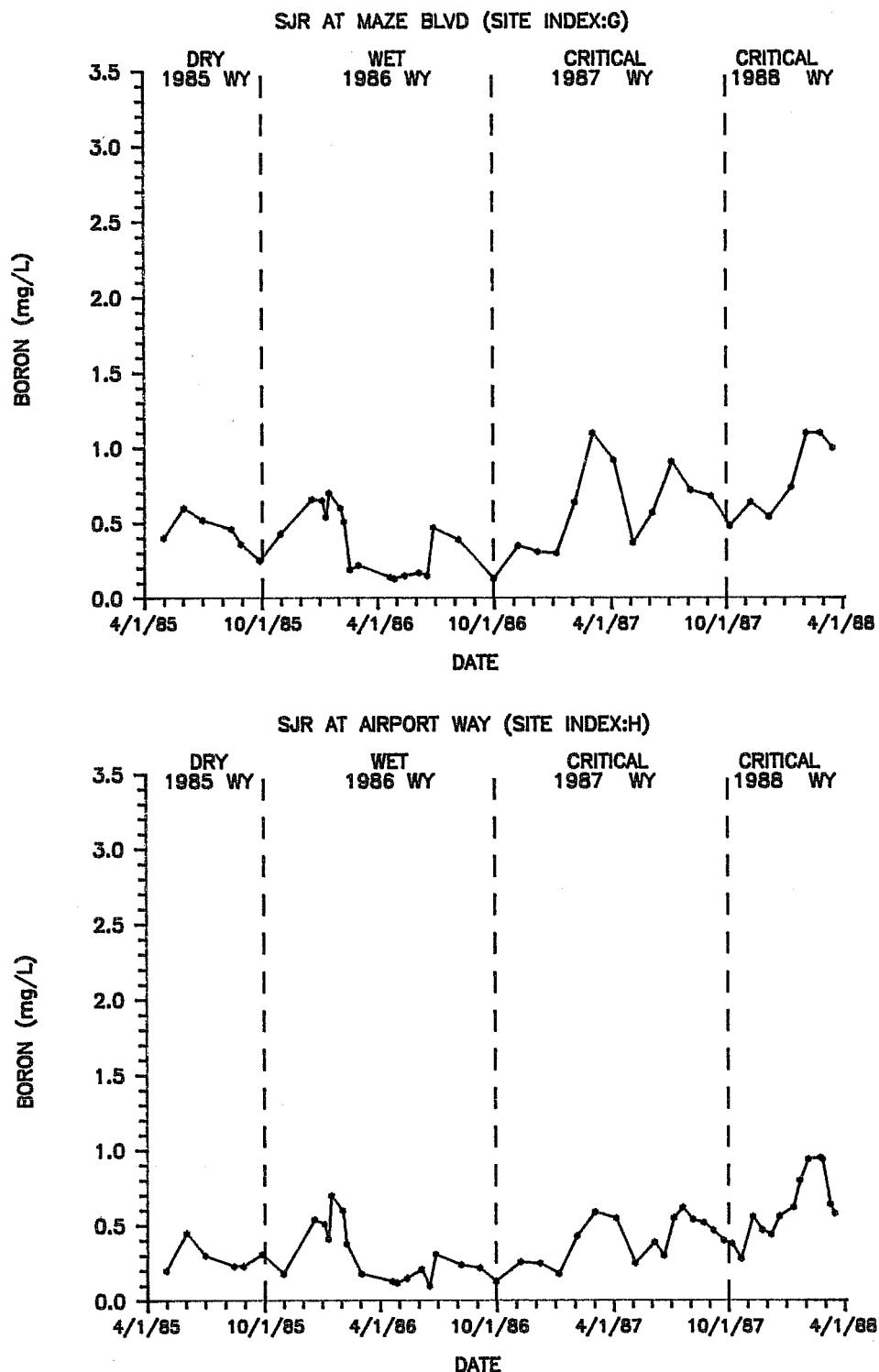


Fig. C2. Boron vs. time at each monitoring site (cont.).

## APPENDIX D



## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA

INDEX.A .....MER522 SAN JOAQUIN RIVER AT LANDER AVENUE

LOCATION .....Latitude 37° 17'43", Longitude 120° 51'01"

In NE 1/4, NE 1/4, SE 1/4, Sec. 27, T.7S., R.10E. East bank,  
 50 ft. W of Lander Avenue (Hwy 165), 2.3 mi. S of Stevinson.  
 River mile 132.9

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
.....ug/L.....									
Total Recoverable									
06/03/85	1325	<1							
07/02/85	1105	<1							
08/15/85	1150	1							
08/29/85	910	<1							
09/28/85	1320	<1							
10/31/85	1245	<1							
12/07/85	1530	1	<5	4	2	<5	<5		<0.5
12/18/85	815	2	<5	<1	1	2	<5	8	<0.2
01/04/86	1330	5	5	1	2	<5	<5		<0.2
01/09/86	910	2	<5	7	2	8	<5		<0.5
01/14/86	1430	1	<5	<1	2	<5	<5		<0.5
02/07/86	1100	<1	<5	2	4	5	<5		<0.5
02/17/86 *	855	<1	<5	4	5	11	<5		<0.5
03/01/86	1650	<1							
04/02/86		<1							
04/19/86	1000	<1	<5	5	<1	<5	<5		<0.5
04/26/86	1435	<1		2	4	2	<5	3	<0.2
05/13/86	1150	<1	<5	<1	1	<5	<5		<0.5
06/03/86	1445	0.7	2	2	<1	<5	<5		<0.5
06/16/86	1615	0.7	2	3	7	4	<5	5	<0.5
06/26/86	1300	0.9	3	2	4	<5	<5	5	<0.5
08/04/86	1505	0.2	2	2	<1	<5	<5	2	<0.5
09/02/86	1120	0.3	2	2	1	<5	<5	7	<0.5
09/27/86	1430	0.3	<1	3	4	<5	<5	8	0.5
11/04/86	725	0.5	4	3	2	<5	<5	<1	
12/04/86		0.5	<5	<1	<1	<5	<5	<1	<0.5
01/02/87	1440	1.6	<5	2	1	<5	<5	2	<0.5
01/30/87	1100	1.8							
02/27/87	1055	0.8							
04/01/87	1100	0.5							
05/01/87	1220	1							
06/01/87	1300	0.7	8						
06/15/87	1250	0.6							
07/01/87	1140	0.6	12						
07/15/87	1220	0.4	14						
07/31/87	1240	0.7	12						
08/17/87	1420	0.7	11						
09/01/87	1245	0.5	6						
09/18/87	1120	0.7	6						
10/01/87	1235	0.4	3						
10/15/87	1010	0.2	3						

(\* Major storm event.)

## APPENDIX...D

## TABLE...1D

INDEX.A .....MER522 SAN JOAQUIN RIVER AT LANDER AVENUE (cont.)

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
-----ug/L-----									
Total Recoverable									
11/03/87	1215	0.4		18					
11/17/87	1210	0.3		22					
12/01/87	1315	1.4		4					
12/14/87	1130	1.1		6					
01/05/88	1245	7.6		5					
01/15/88	1100	2.3							
01/27/88	1750	1.0							
02/16/88	1155	1.4							
03/02/88	1130	0.8							
03/09/88	1230	0.4							

## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA.

INDEX.B .....MER538 SAN JOAQUIN RIVER AT FREMONT FORD

LOCATION .....Latitude 37 18'34", Longitude 120 55'45"  
 In NW 1/4, NW 1/4, SE 1/4, Sec. 24, T.7S., R.9E.  
 West bank at Fremont Ford State Rec. Area, 50 ft S of Hwy 140,  
 5.4 miles NE of Gustine. River mile 125.1.

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
ug/L.....									
Total Recoverable									
05/02/85	1445	7							
06/03/85	1340	4							
07/02/85	1120	5							
08/14/85	1830	3							
08/29/85	925	2							
09/28/85	1335	<1							
10/30/85	1700	1							
12/07/85	1545	3	8	6	4	9	<5		<0.5
12/18/85	840	1	7	7	2	12	<5	7	<0.2
01/04/86	1355	3	17	5	2	5	<5		<0.2
01/09/86	955	9	15	2	2	26	<5		<0.5
01/14/86	1410	6	9	1	2	6	<5		<0.5
02/07/86	1115	8	7	2	4	11	<5		<0.5
02/16/86 *	1525	3	<5	3	4	12	<5		<0.5
03/02/86	1630	1	<5	2	1	51	<5		<0.5
04/02/86		<1							
04/19/86	1015	<1	<5	3	<1	5	<5		<0.5
04/26/86	1400	<1		2	3	1	<5	3	<0.2
05/13/86	1215	<1	<5	2	1	<5	<5		<0.5
06/03/86	1420	1.4	3	<1	<1	6	<5		<0.5
06/16/86	1555	1.6	<5	9	14	7	<5	12	<0.5
06/26/86	1245	1.7	<5	4	12	7	<5	15	<0.5
08/04/86	1435	4.7	<5	4	1	8	<5	17	<0.5
09/02/86	1100	5.1	<5	6	2	5	<5	16	<0.5
09/27/86	1405	3.1	<5	6	7	5	<5	12	<0.5
11/04/86	745	7.4	5	4	6	7	<5	1	
12/04/86		13	<5	<1	4	<5	<5	<1	<0.5
01/02/87	1425	12	9	2	3	<5	<5	3	<0.5
01/30/87	1045	18							
02/27/87	1045	26							
04/01/87	1045	13							
05/01/87	1205	7.7							
06/01/87	1245	10							
07/01/87	1155	11							
07/15/87	1200	8.5							
07/31/87	1255	9.5							
08/17/87	1405	6.1							
09/01/87	1300	4.3							
09/18/87	1100	9.5							
10/01/87	1250	8.8							
10/15/87	955	1.3							

(\* Major storm event.)

## APPENDIX...D

## TABLE...1D

INDEX.B .....MER538 SAN JOAQUIN RIVER AT FREMONT FORD (cont.)

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
.....ug/L.....									
Total Recoverable									
11/03/87	1200	4.7							
11/17/87	1140	7.5							
12/01/87	1300	7.6							
12/14/87	1110	8.2							
01/05/88	1230	16							
01/15/88	1020	17							
01/28/88	1310	13							
02/16/88	1135	23							
03/02/88	1115	14							
03/09/88	1215	14							

## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA.

INDEX.C ..... STC512 SAN JOAQUIN RIVER SOUTH OF HILLS FERRY ROAD

LOCATION ..... Latitude 37° 20'33", Longitude 120° 58'38"

In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T.7S., R.9E.

West bank, 0.9 miles SE of Hills Ferry Rd at abandoned tallow factory,  
immediately upstream of Merced River inflow, 3.3 mi. NE of Newman.  
River mile 118.8.

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
..... ug/L.....									
Total Recoverable									
05/02/85	1525	7							
06/03/85	1430	4							
07/02/85	1345	8							
08/14/85	1600	4							
08/29/85	1145	3							
09/27/85	1720	1							
10/30/85	1445	1							
12/18/85	1015	<1	7	4	3	13	<5	7	<0.2
01/03/86	1635	6	14	8	3	6	<5		<0.2
01/09/86	1120	8	10	4	2	22	<5		<0.5
01/14/86	1045	7	7	<1	3	17	<5		<0.5
02/01/86	1205	7	11	16	7	9	<5		<0.5
02/07/86	1240	6	14	4	5	10	<5		<0.5
02/16/86 *	1215	4	<5	4	6	10	<5		<0.5
03/01/86	1245	2	7	6	<1	7	<5		<0.5
04/02/86		2							
04/19/86	1050	2	<5	4	1	10	<5		<0.5
04/26/86	1105	2		2	2	4	<5	4	<0.2
05/12/86	1645	2	<5	3	2	<5	<5		<0.5
06/03/86	1050	3.4	4	2	2	9	<5		<0.5
06/16/86	1515	4.1	4	10	16	9	<5	15	<0.5
06/26/86	1000	5.6	5	4	15	5	<5	15	<0.5
08/04/86	1115	6.5	5	4	2	7	<5	19	<0.5
09/02/86	1210	4.6	4	5	5	7	<5	14	<0.5
09/27/86	1045	2.9	3	4	7	6	<5	7	<0.5
11/04/86	9035	7.7	7	3	5	6	<5	<1	
12/04/86		6.6	<5	<1	<1	5	<5	<1	<0.5
01/02/87	1105	11	10	3	3	7	<5	4	<0.5
01/30/87	930	11	9	2	<1	<5	<5	7	<0.5
02/27/87	920	21	12	3	6	7	<5		9
04/01/87	930	13	12	2	6	9	<5		10
05/01/87	1030	6.7	8	3	6	6	<5		12
06/01/87	1130	9.5	7	6	12	10	<5		16
06/15/87	1030	12		6	7	11	<5		17
07/01/87	1315	8.1	6	8	13	13	<5		20
07/15/87	1112	8.9		6	9	14	<5		18
07/31/87	1335	11		7	8	12	<5		20
08/17/87	1325	11		6	6	10	<5		13
09/01/87	1400	21	7	6	13	12	<5		19
09/18/87	1030	7.6	7	3	8	9	<5		15

(\* Major storm event.)

## APPENDIX...D

## TABLE...1D

INDEX.C .....STC512 SAN JOAQUIN RIVER SOUTH OF HILLS FERRY ROAD (cont.)

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
.....ug/L.....									
Total Recoverable									
10/01/87	1350	6.3	8	3	8	8	5	11	
10/15/87	915	1.0	5	2	6	6	<5	9	
11/03/87	1050	4	6	4	7	9	<5	12	
11/17/87	1040	6.1	8	2	6	6	<5	8	
12/01/87	1145	6.4	7	1	3	<5	<5	10	
12/14/87	1030	6.4	11	2	2	5	14	7	
01/05/88	1010	9.2	11	3	5	5	<5	10	
01/15/88	1215	12		3	6	8	<5	9	
01/28/88	1235	9.3		4	7	7	<5	11	
02/16/88	1055	17		4	9	8	<5	12	
02/19/88	1645	20		4	8	6	<5	8	
03/02/88	1025	12		7	13	12	<5	17	
03/09/88	1055	14		6	12	10	<5	16	

## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA.

INDEX.D ..... STC504 SAN JOAQUIN RIVER AT CROWS LANDING ROAD

LOCATION ..... Latitude 37° 25' 55", Longitude 121° 00' 42"  
 In SW 1/4, NW 1/4, NW 1/4, Sec. 8, T.6S., R.8E.  
 West bank, 100 yd. S of Crows Landing Road Bridge, 4.2 mi. NE  
 of Crows Landing. River mile 107.2.

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
ug/L.....									
Total Recoverable									
05/02/85	1545	3							
06/03/85	1455	3							
07/02/85	1410	4							
08/14/85	1530	3							
08/29/85	1200	2							
09/27/85	1700	1							
10/30/85	1415	1							
12/18/85	1045	2	7	2	1	9	<5	6	<0.2
01/03/86	1610	4	14	<1	2	<5	<5		<0.2
01/09/86	1150	4	8	3	<1	21	<5		<0.5
01/14/86	1020	3	<5	<1	2	9	<5		<0.5
02/01/86	1140	3	6	4	3	9	<5		<0.5
02/07/86	1300	4	5	2	4	8	<5		<0.5
02/16/86 *	1155	2	<5	4	29	30	<5		<0.5
03/02/86	1220	1	<5	2	1	8	<5		<0.5
04/02/86		<1							
04/19/86	1115	1	<5	<1	1	6	<5		<0.5
04/26/86	1045	1	<1	2	2	3	<5	3	<0.2
05/12/86	1610	<1	<5	2	2	<5	<5		<0.5
06/03/86	1020	1.9							
06/16/86	1450	2.7							
06/26/86	930	3.4							
08/04/86	1055	3.6	<5	3	2	6	<5	14	<0.5
09/02/86	1145	3	<5	3	4	5	<5	10	<0.5
09/27/86	1025	1.6	<5	4	5	<5	<5	4	<0.5
11/04/86	1000	3.6	<5	3	4	5	<5	<1	
12/04/86		5.3	<5	<1	<1	<5	<5	<1	<0.5
01/02/87	1045	4.9	5	2	2	<5	<5	1	<0.5
01/30/87	910	6.6							
02/27/87	900	12							
04/01/87	905	8.5							
05/01/87	1015	5.5							
06/01/87	1100	5.9	5						
06/15/87	1005	6.7							
07/01/87	1330	4.8	4						
07/15/87	1050	6.2	4						
07/31/87	1405	5.8	4						
08/17/87	1300	5.6	4						
09/01/87	1420	4.8	5						
09/18/87	1005	3.6	4						
10/01/87	1410	2.9	4						

(\* Major storm event.)

## APPENDIX...D

## TABLE...1D

INDEX.D .....STC504 SAN JOAQUIN RIVER AT CROWS LANDING ROAD (cont.)

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
.....ug/L.....									
Total Recoverable									
10/15/87	900	0.8	4						
11/03/87	1030	3	5						
11/17/87	1020	2.6	4						
12/01/87	1120	2.8	4						
12/14/87	1010	2.9	6						
01/05/88	1055	5.3	6						
01/15/88	1250	7.8							
01/28/88	1215	6.7							
02/16/88	1030	12							
02/19/88	1615	12							
03/02/88	1000	8.4							
03/09/88	1040	8.8							

## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA.

INDEX.E ..... STC507 SAN JOAQUIN RIVER NORTH OF LAS PALMAS AVENUE

LOCATION ..... Latitude 37 29'52", Longitude 121 04'54"  
 In SW 1/4, NW 1/4, SW 1/4, Sec. 15, T.5S., R.8E.  
 West bank, 0.3 miles N of Las Palmas Ave. Bridge at corner of Las  
 Palmas Launching Facility parking lot, 3.2 mi. NE of  
 Patterson. River mile 98.4.

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
ug/L.....									
Total Recoverable									
05/02/85	1615	4							
06/03/85	1515	3							
07/02/85	1445	4							
08/14/85	1505	3							
08/29/85	1230	1							
09/27/85	1640	<1							
10/30/85	1330	1							
12/18/85	1115	2	6	2	1	6	<5	<1	<0.2
01/03/86	1545	3	10	3	1	<5	<5		<0.2
01/09/86	1225	5	7	<1	<1	16	<5		<0.5
01/14/86	955	3	12	<1	1	5	<5		<0.5
02/01/86	1120	4	7	8	3	8	<5		<0.5
02/07/86	1325	4	5	1	3	8	<5		<0.5
02/16/86 *	1135	2	<5	6	11	42	<5		<0.5
03/01/86	1200	1	<5	7	<1	8	<5		<0.5
04/19/86	1220	1	<5	2	<1	6	<5		<0.5
04/26/86	1025	<1	<1	2	2	3	<5	5	<0.2
05/12/86	1540	<1	<5	3	2	<5	<5		<0.5
06/03/86	1000	1.7	<5	3	<1	7	<5		<0.5
06/16/86	1430	2.4	<5	5	10	7	<5	10	<0.5
06/26/86	915	2.8	<5	7	6	6	<5	16	<0.5
08/04/86	1030	3.2	<5	4	2	5	<5	14	<0.5
09/02/86	1125	2.7	<5	3	3	5	<5	9	<0.5
09/27/86	1000	1.1	<5	3	3	<5	<5	2	<0.5
11/04/86	1025	3.4	<5	3	4	5	<5	<1	
12/04/86		5.2	<5	<1	<1	<5	<5	<1	<0.5
01/02/87	1025	4.7	6	2	2	<5	<5	1	<0.5
01/30/87	855	4.7							
02/27/87	845	10							
04/01/87	840	7.9							
05/01/87	1000	3.8							
06/01/87	1055	5.4							
07/01/87	1355	4.5							
07/31/87	1435	5.8							
09/01/87	1450	4.8							
10/01/87	1430	3.1							
11/03/87	1015	3							
12/01/87	1050	3.4							
01/05/88	1040	6							
01/28/88	1150	6.3							
02/19/88	1555	9							
03/09/88	1020	8.5							

(\* Major storm event.)

## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA.

INDEX.F ..... STC511 SAN JOAQUIN RIVER AT GRAYSON ROAD (LAIRD SLOUGH)

LOCATION ..... Latitude 37 33'43", Longitude 121 09'03"

In NW 1/4, SE 1/4, NW 1/4, Sec. 25, T.4S., R.7E.

Laird Park, 500 ft. S of Grayson Road Bridge, 1.5 mi. E of  
Grayson, River mile 89.1

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
ug/L.....									
Total Recoverable									
06/03/85	1540	3							
07/02/85	1510	3							
08/14/85	1435	2							
08/29/85	1255	1							
09/27/85	1610	1							
10/30/85	1305	1							
12/18/85	1240	<1	<5	3	2	7	<5	8	<0.2
01/03/86	1515	4	7	8	2	<5	<5		<0.2
01/09/86	1320	4	7	4	2	22	<5		<0.5
01/14/86	930	3							
02/01/86	1040	4	13	4	5	11	<5		<0.5
02/07/86	1400	3	13	5	5	11	<5		<0.5
02/16/86 *	1110	2	<5	6	13	54	<5		<0.5
03/01/86	1125	1	<5	4	1	8	<5		<0.5
04/02/86		<1							
04/26/86	1000	<1	<1	3	8	4	<5	5	<0.2
06/03/86	930	1.7							
06/26/86	845	3.2	<5	4	15	6	<5	14	<0.5
08/04/86	1010	3.5	<5	4	2	7	<5	18	<0.5
09/02/86	1055	2.4	<5	7	4	6	<5	11	<0.5
09/27/86	930	0.9	<5	4	4	<5	<5	4	<0.5
11/04/86	1050	3.4	<5	3	3	<5	<5	<1	
12/04/86	1615	4.6	<5	<1	<1	<5	<5	<1	<0.5
01/02/87	1000	4.5	<5	3	2	<5	<5	3	<0.5
01/30/87	830	5.9							
02/27/87	825	9.3							
04/01/87	820	8.4							
05/01/87	935	3.7							
06/01/87	1035	5.4							
07/01/87	1420	4.1							
07/31/87	1500	5							
09/01/87	1515	4.2							
10/01/87	1445	2.9							
11/03/87	955	2.5							
12/01/87	1030	2.4							
01/05/88	1015	4.8							
01/28/88	1125	6							
03/09/88	1000	8.5							

(\* Major storm event.)

## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA.

INDEX.G ..... STC510 SAN JOAQUIN RIVER AT MAZE BLVD. (HWY 132)

LOCATION ..... Latitude 37° 38'31", Longitude 121° 13'40"  
 In SW 1/4, NW 1/4, SW 1/4, Sec. 29, T.3S., R.7E.  
 West bank, 400 ft. S of Maze Blvd Bridge, upstream of Blewett Drain,  
 5.7 mi. NW of Grayson. River mile 77.3.

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
ug/L.....									
Total Recoverable									
05/02/85	1705	2							
06/03/85	1605	2							
07/02/85	1535	3							
08/14/85	1410	2							
08/29/85	1325	2							
09/27/85	1535	1							
10/30/85	1230	1							
12/18/85	1320	<1	<5	<1	3	9	<5	10	<0.2
01/03/86	1455	2	8	1	<1	<5	<5		<0.2
01/09/86	1550	2	6	2	1	22	<5		<0.5
01/14/86	905	2	<5	1	5	9	<5		<0.5
02/01/86	1015	2	<5	2	2	10	<5		<0.5
02/07/86	1430	2	8	2	3	6	<5		<0.5
02/16/86 *	1045	2	<5	6	14	49	<5		<0.5
03/01/86	1100	1	<5	2	2	10	<5		<0.5
04/02/86		<1							
04/19/86	1250	<1	<5	2	<1	<5	<5		<0.5
04/26/86	930	<1	<1	3	3	7	<5	8	<0.2
05/12/86	1500	<1	<5	2	<1	10	<5		<0.5
06/03/86	915	0.9							
06/16/86	1400	1.5	<5	4	8	5	<5	7	<0.5
06/26/86	830	2.3							
08/04/86	1000	2.4	<5	5	3	8	<5	20	<0.5
09/02/86	1030	2.1	<5	4	4	6	<5	11	<0.5
09/27/86	910	0.8	<5	5	4	<5	<5	2	<0.5
11/04/86	1115	1.5	<5	2	3	<5	<5	<1	
12/04/86	1630	2.1	<5	<1	<1	<5	<5	<1	<0.5
01/02/87	935	1.4	<5	2	1	<5	<5	2	<0.5
01/30/87	805	2.8							
02/27/87	805	5.8							
04/01/87	800	4.9							
05/01/87	915	2.2							
06/01/87	1010	3.7							
07/01/87	1440	3.3							
07/31/87	1525	4							
09/01/87	1540	3.6							
10/01/87	1510	2.2							
11/03/87	935	2.3							
12/01/87	1005	1.9							
01/05/88	955	3.4							
01/28/88	1100	5.1							
02/19/88	1105	6.5							
03/09/88	945	6							

(\* Major storm event.)

## APPENDIX D

## TABLE 1D. TRACE ELEMENT WATER QUALITY DATA.

INDEX.H ..... SJC501 SAN JOAQUIN RIVER AT AIRPORT WAY

LOCATION ..... Latitude 37° 40'32", Longitude 121° 15'51"  
 In SE 1/4, SW 1/4, NW 1/4, Sec. 13, T.3S., R.6E.  
 West bank, 50 ft. S of Airport Way Bridge, 3.2 mi. NE of  
 Vernalis. River mile 73.6.

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
ug/L.....									
		Total Recoverable							
05/02/85	1725	2							
06/03/85	1625	1							
07/02/85	1555	1							
08/14/85	1345	1							
08/29/85	1325	1							
09/27/85	1515	1							
10/30/85	1155	<1							
12/18/85	1345	4	<5	<1	<1	2	<5	6	<0.2
01/03/86	1430	2	<5	6	2	5	<5		<0.2
01/09/86	1605	1	<5	<1	1	21	<5		<0.5
01/14/86	840	1	<5	<1	<1	8	<5		<0.5
02/01/86	950	2		3	3	6	<5		<0.5
02/07/86	1445	2	<5	2	3	7	<5		<0.5
02/16/86 *	1025	2	<5	17	72	60	<5		<0.5
03/02/86	1040	1	<5	1	1	8	<5		<0.5
04/02/86		<1							
04/19/86	1315	1	<5	3	<1	5	<5		
04/26/86	915	<1	<1	2	2	3	<5	4	<0.2
05/12/86	1430	<1	<5	<1	<1	<5	<5		<0.5
06/03/86	850	0.6	<5	4	<1	<5	<5		<0.5
06/16/86	1330	1	<1	4	3	5	<5	6	<0.5
06/26/86	800	1.4	2	3	8	<5	<5	9	<0.5
08/04/86	935	1.7	1	3	<1	<5	<5	10	<0.5
09/02/86	1000	1.4	2	3	3	4	<5	8	<0.5
09/27/86	850	0.6	<1	5	4	<5	<5	2	<0.5
11/04/86	1130	1.2	2	2	2	<5	<5	<1	
12/04/86	1650	1.7	<5	<1	<1	<5	<5	<1	<0.5
01/02/87	915	0.9	<5	2	1	<5	<5	1	<0.5
01/30/87	750	2.4	2						
02/27/87	745	3.2							
04/01/87	745	2.9							
05/01/87	900	1.6							
06/01/87	1000	2.8	1						
06/15/87	920	2.3							
07/01/87	1500	2.2	2						
07/15/87	1000	2.5	2						
07/31/87	1540	2.9	2						
08/17/87	950	2.8	2						
09/01/87	1610	2.3	2						
09/18/87	915	1.9	2						
10/01/87	1535	1.8	2						

(\* Major storm event.)

## APPENDIX...D

## TABLE...1D

INDEX.H ..... SJC501 SAN JOAQUIN RIVER AT AIRPORT WAY (cont.)

DATE	TIME	Se	Mo	Cu	Cr	Ni	Pb	Zn	Hg
		ug/L							
		Total Recoverable							
10/15/87	810	0.77		3					
11/03/87	920	2		3					
11/17/87	945	1.8		2					
12/01/87	940	1.7		3					
12/14/87	930	1.6		4					
01/05/88	935	3.1							
01/15/88	1330	3.3							
01/28/88	1045	3.7							
02/16/88	940	6.5							
02/19/88	1000	6.5							
03/02/88	930	4							
03/09/88	925	3.7							

**APPENDIX D**

TABLE 2D. SUMMARY OF TRACE ELEMENT WATER QUALITY DATA FROM MAY 1985 TO MARCH 1988

		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY RD.	FREMONT FORD	LANDER AVENUE
<b>Se</b> ( $\mu\text{g/L}$ )	Minimum	0.60 (<1)	0.80 (<1)	0.90 (<1)	<1	0.83 (<1)	0.96 (<1)	<1	0.20 (<1)
	Median	1.8	2	3.1	3.2	3.6	6.6	6.1	0.55
	Maximum	6.5	6.5	9.3	10	12	21	26	5
	# Samples	(53)	(43)	(38)	(43)	(53)	(53)	(51)	(51)
<b>Mo</b> ( $\mu\text{g/L}$ )	Minimum	0.5 (<1)	<1	<1	<1	<1	2.6 (<5)	2.9	0.4 (<5)
	Median	2	<5	<5	<5	4	1.4	<5	2.9
	Maximum	4 (<5)	8	13	12	14	17	17	22
	# Samples	(33)	(18)	(15)	(20)	(31)	(28)	(19)	(32)
<b>Cu</b> ( $\mu\text{g/L}$ )	Minimum	<1	<1	<1	<1	<1	<1	<1	<1
	Median	2.5	2	4	3	2	4	3	2
	Maximum	1.7	6	8	8	4	16	9	7
	# Samples	(20)	(18)	(15)	(20)	(17)	(45)	(20)	(19)
<b>Cr</b> ( $\mu\text{g/L}$ )	Minimum	<1	<1	<1	<1	<1	<1	<1	<1
	Median	1.5	3	3	2	2	6	2.5	2
	Maximum	7.2	14	15	11	2.9	16	14	7
	# Samples	(20)	(18)	(15)	(20)	(17)	(45)	(20)	(19)
<b>Ni</b> ( $\mu\text{g/L}$ )	Minimum	2 (<5)	<5	4 (<5)	3 (<5)	3 (<5)	4 (<5)	1 (<5)	2 (<5)
	Median	3.5 (<5)	6.5	6	5.5	6	8.5	6.5	<5
	Maximum	6.0	4.9	5.4	4.2	3.0	2.2	5.1	1.1
	# Samples	(20)	(18)	(15)	(20)	(17)	(45)	(20)	(19)
<b>Zn</b> ( $\mu\text{g/L}$ )	Minimum	<1	<1	<1	<1	<1	<1	<1	<1
	Median	5	7	5	3.5	3.5	11.5	9.5	4
	Maximum	10	20	18	16	14	20	17	8
	# Samples	(10)	(9)	(9)	(10)	(8)	(35)	(10)	(10)

WY 1985 DRY	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se ( $\mu\text{g/L}$ )	Minimum Median Maximum # Samples	1 1 2 (6)	1 2 3 (6)	1 2 3 (6)	<1 3 4 (6)	1 3 4 (6)	<1 3.5 7 (6)	<1 <1 1 (5)
WY 1986 WET	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se ( $\mu\text{g/L}$ )	Minimum Median Maximum # Samples	0.6 (<1) 1 4 (19)	0.8 (<1) 1.5 2.4 (19)	0.9 (<1) 2.2 4 (16)	<1 2 5 (18)	<1 2 4 (19)	<1 4 8 (19)	0.2 (<1) 0.3 5 (19)
Mo ( $\mu\text{g/L}$ )	Minimum Median Maximum # Samples	0.6 (<1) 1.6 (<5) 8 (16)	<1 <5 8 (15)	<1 <5 13 (12)	<1 <5 12 (17)	<1 <5 14 (14)	2.6 (<5) 5.1 14 (16)	<1 <5 17 (16)
WY 1987 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se ( $\mu\text{g/L}$ )	Minimum Median Maximum # Samples	0.9 2.3 3.2 (15)	1.4 3.3 5.8 (11)	3.4 4.6 9.3 (11)	3.4 4.8 10 (11)	3.6 5.6 10 (15)	6.6 11 21 (15)	4.3 10 26 (14)
Mo ( $\mu\text{g/L}$ )	Minimum Median Maximum # Samples	1 (<5) 2 (<5) 2 (<5) (11)	<5 <5 <5 (3)	<5 <5 <5 (3)	<5 <5 6 (3)	4 (<5) 4 5 (10)	<5 7 12 (11)	<1 <5 9 (3)
WY 1988 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se ( $\mu\text{g/L}$ )	Minimum Median Maximum # Samples	0.77 3.3 6.5 (13)	1.9 3.4 6.5 (7)	2.4 3.9 8.5 (6)	3 6 9 (7)	0.83 5.3 12 (13)	1 9.2 20 (13)	1.3 11 23 (12)
Mo ( $\mu\text{g/L}$ )	Minimum Median Maximum # Samples	2 3 4 (6)			4 4 6 (7)	7 11 (3)	5 5 22 (7)	3 5 22 (7)

Appendix D. Table 3D. Summary of selenium and molybdenum data by water year type.



## APPENDIX E



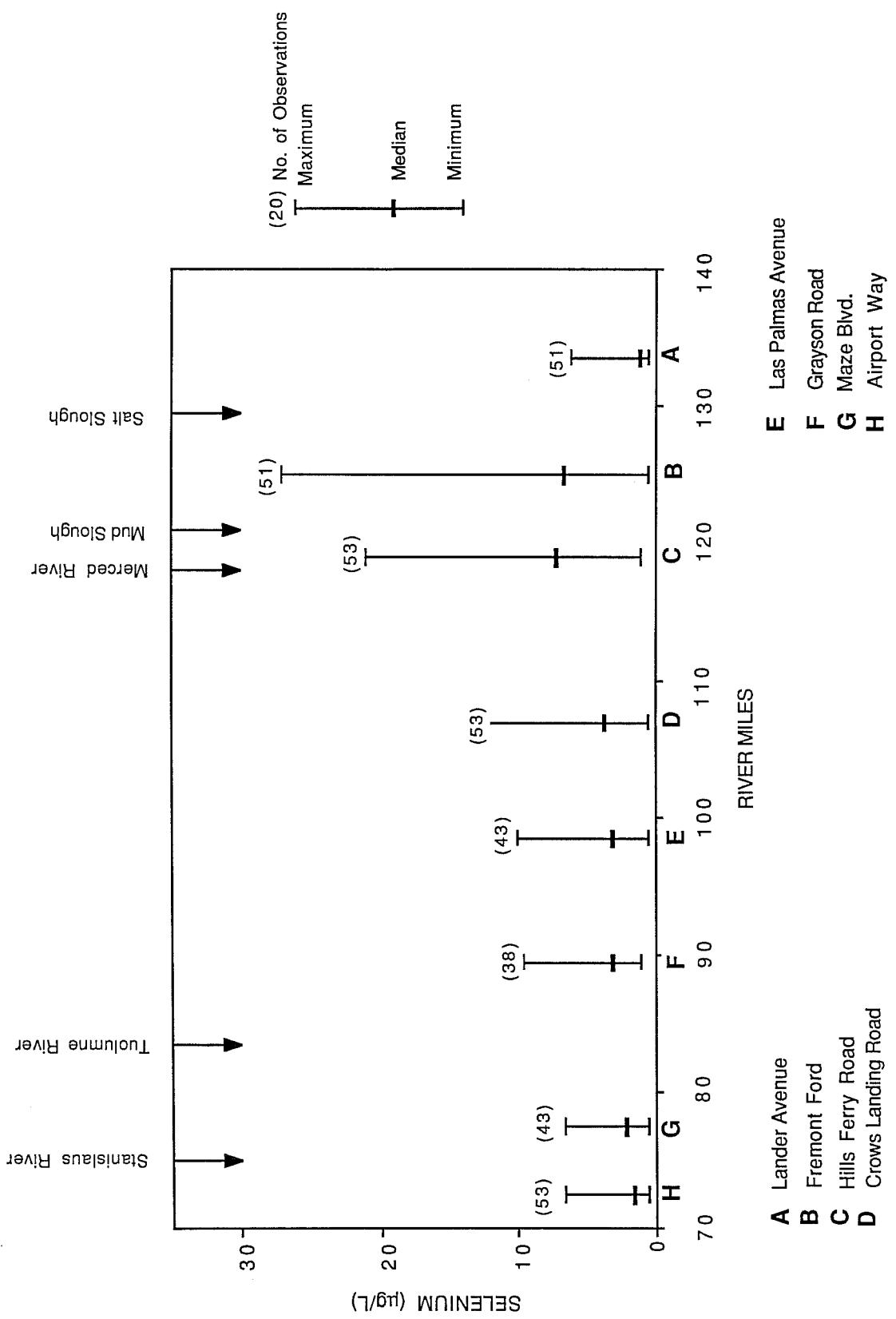


Fig. E1. San Joaquin River Selenium Concentrations

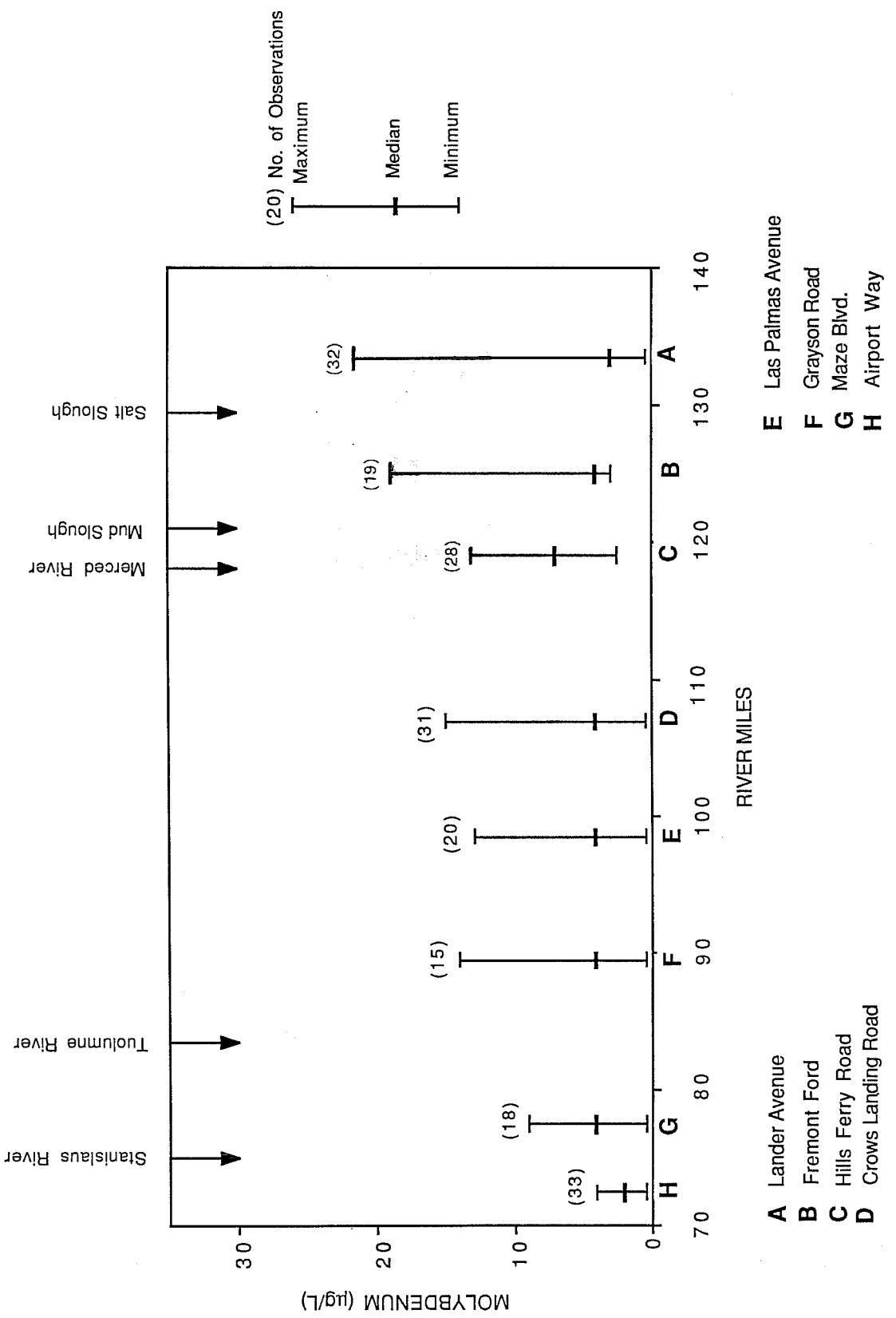


Fig. E2. San Joaquin River Molybdenum Concentrations

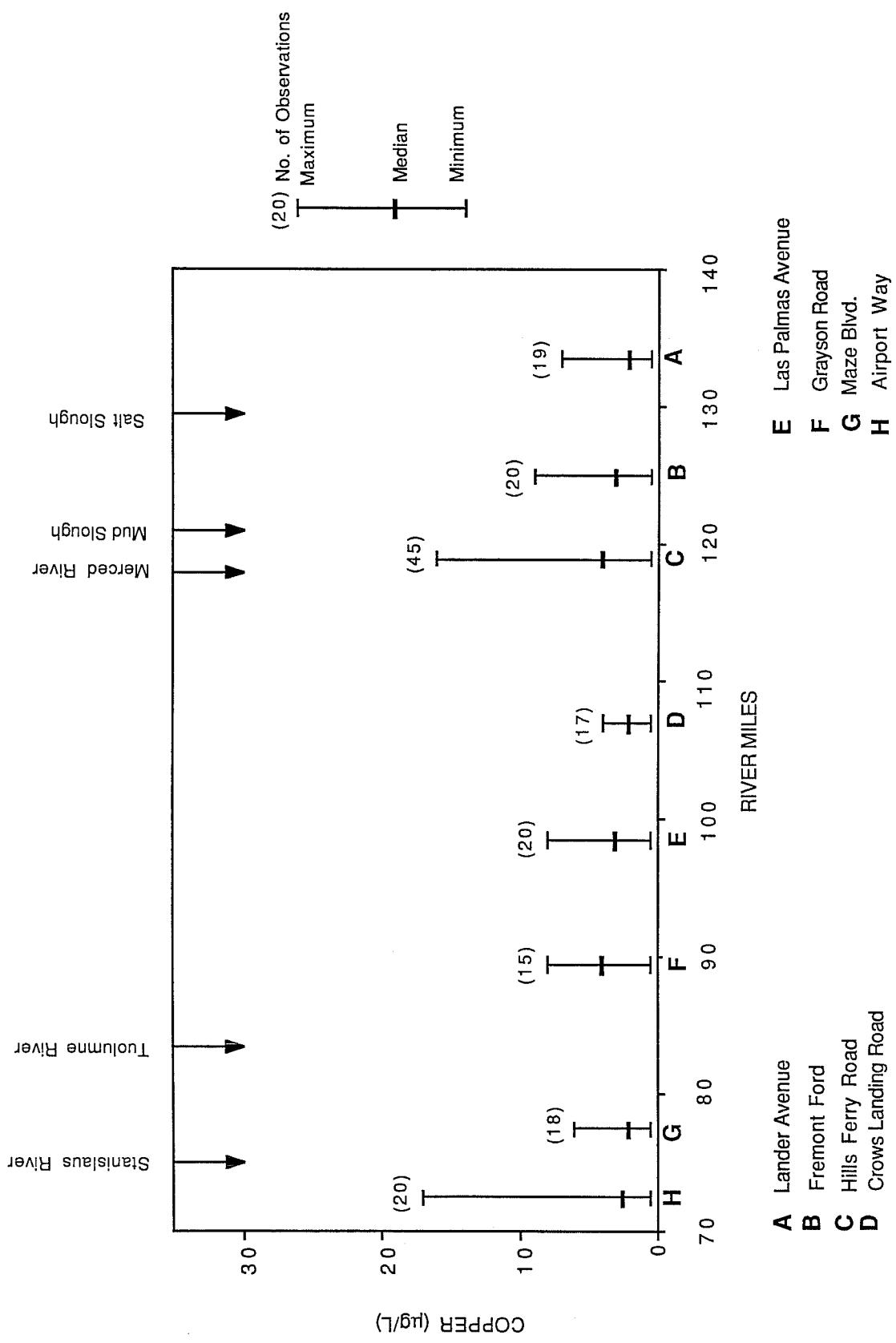


Fig. E3. San Joaquin River Copper Concentrations

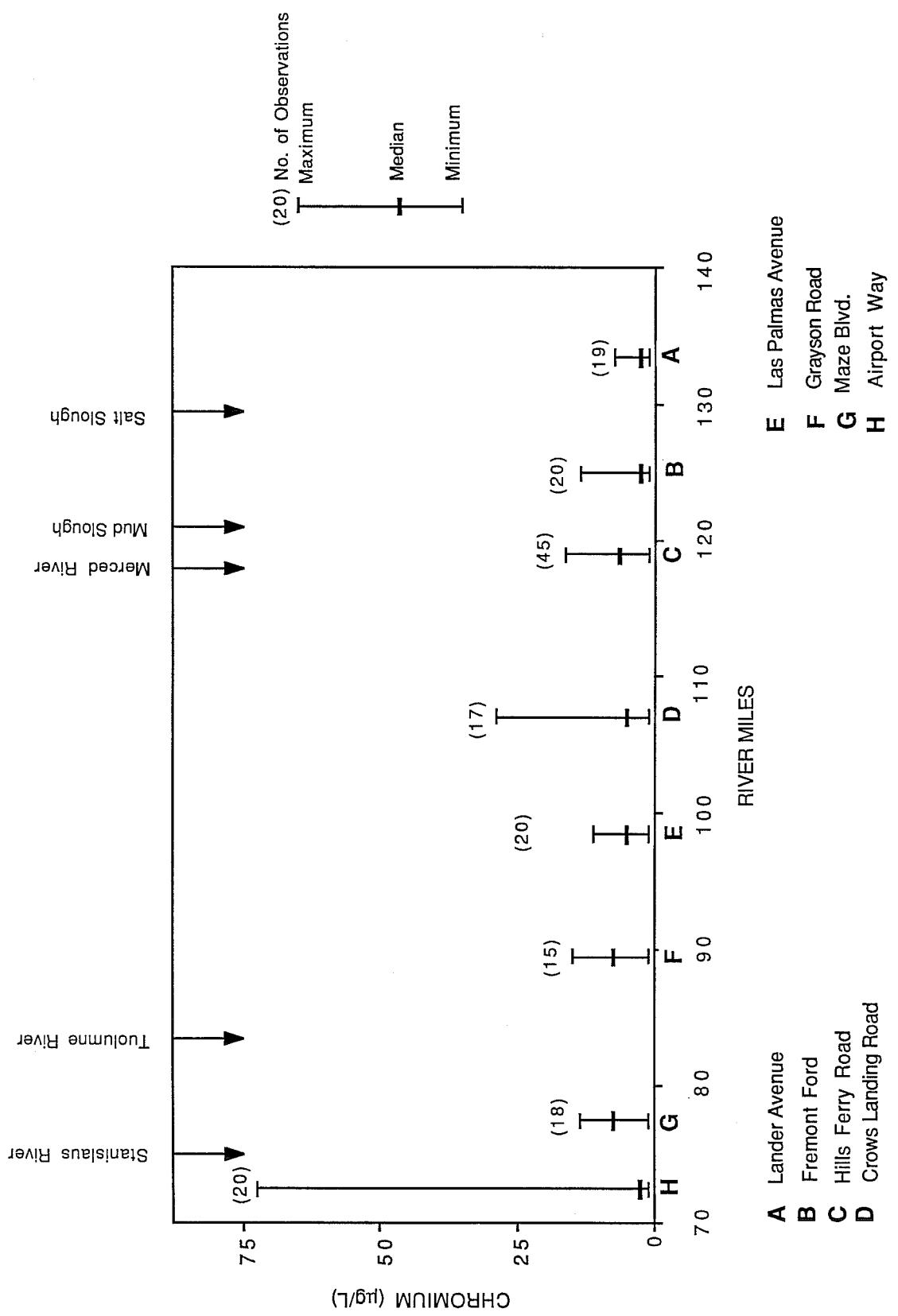


Fig. E4. San Joaquin River Chromium Concentrations

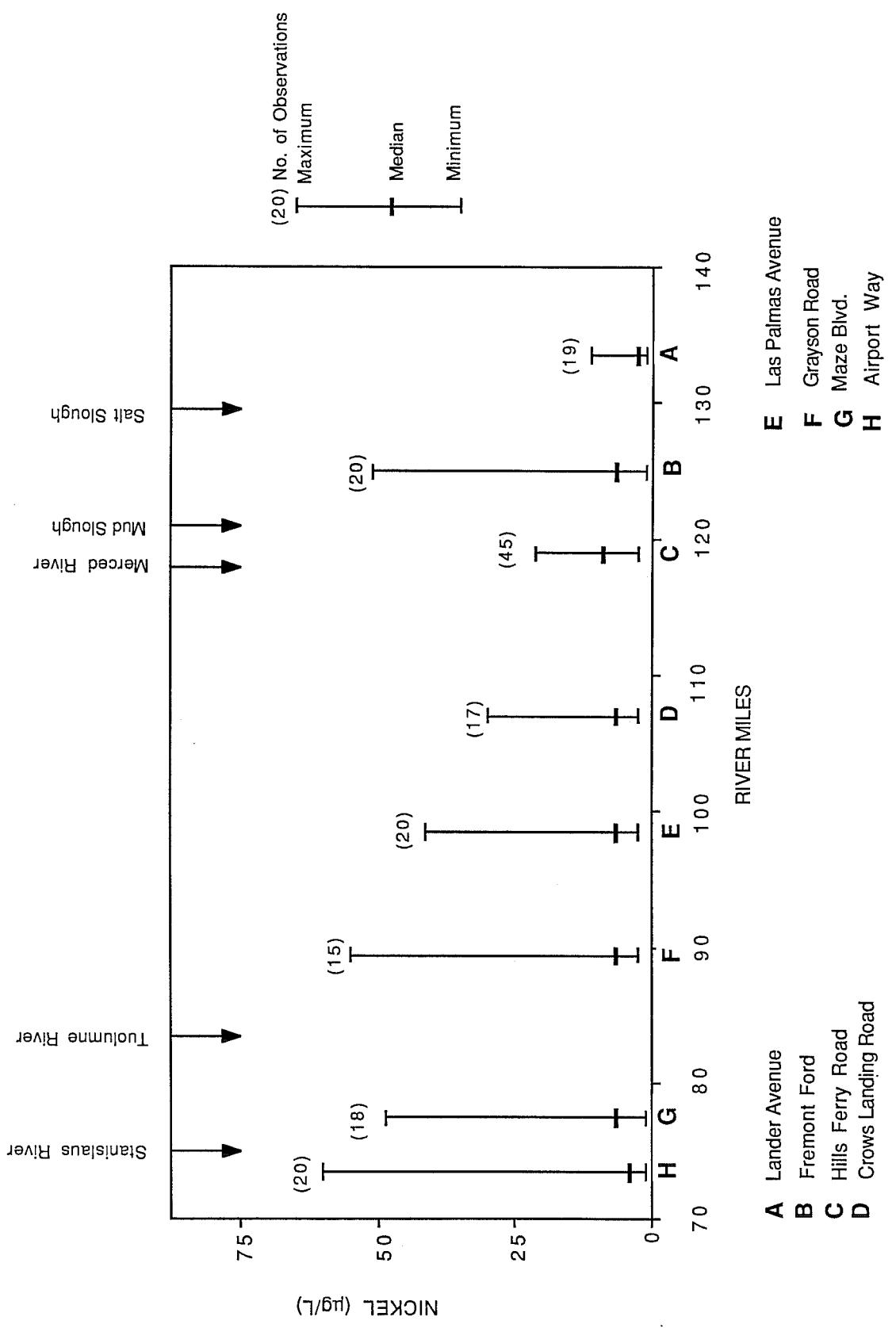


Fig. E5. San Joaquin River Nickel Concentrations

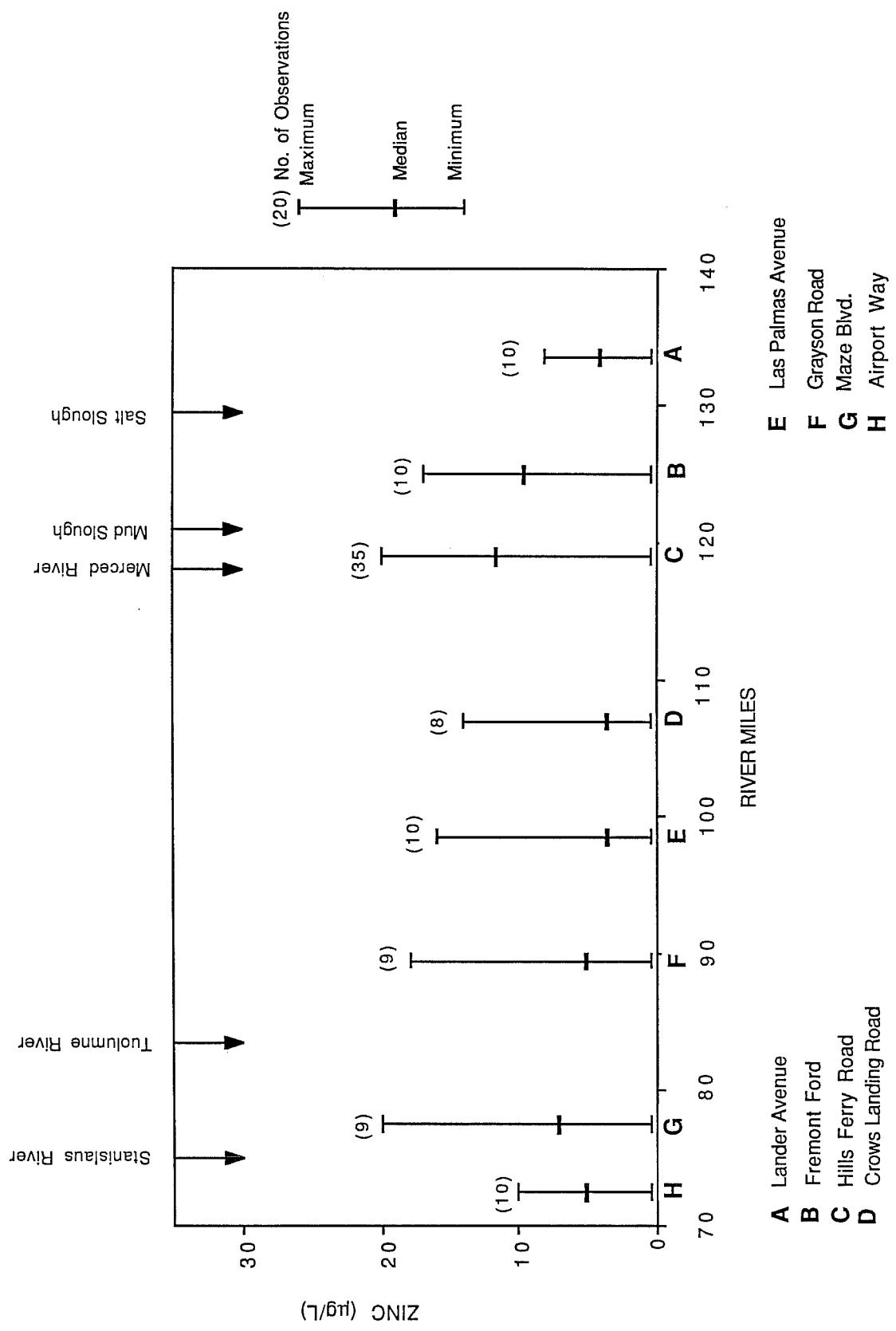


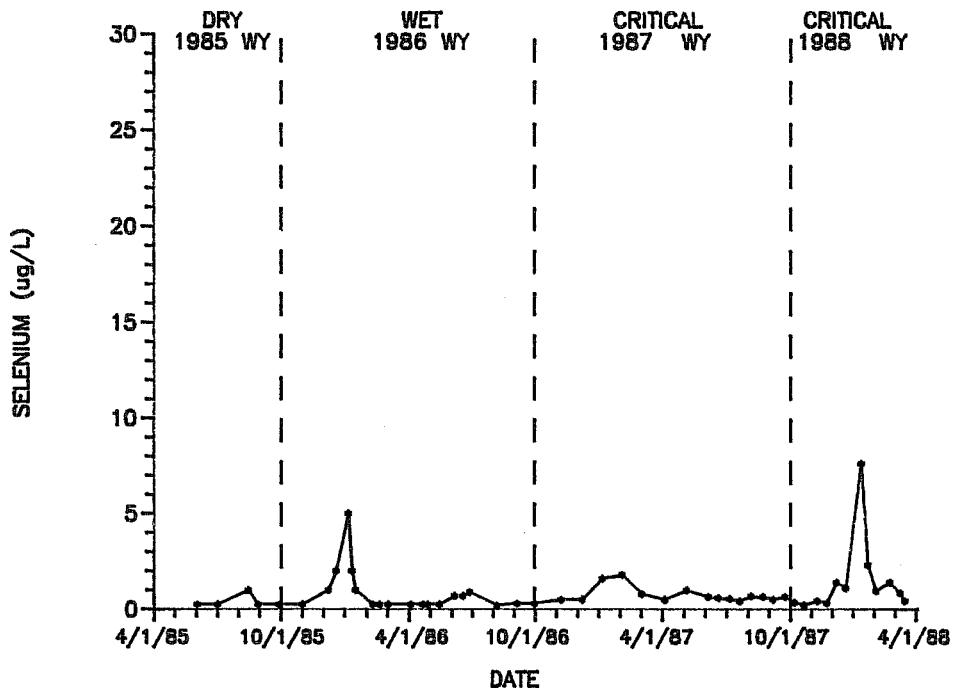
Fig. E6. San Joaquin River Zinc Concentrations

## **APPENDIX F**



## SELENIUM vs. TIME

SJR AT LANDER (SITE INDEX:A)



SJR AT FREMONT FORD (SITE INDEX:B)

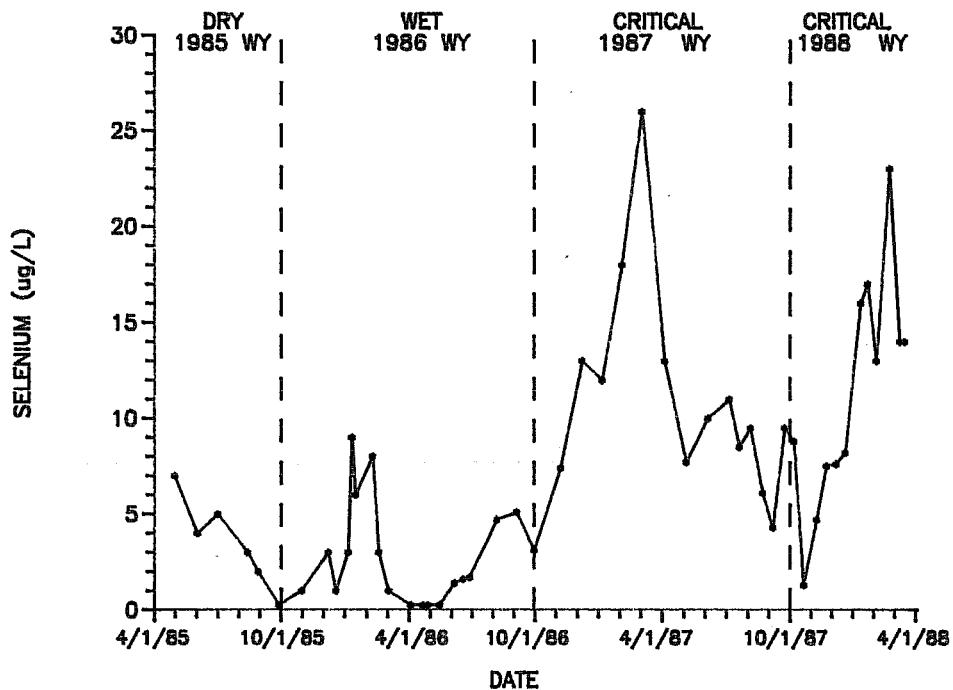


Fig. F1. Selenium vs. time at each monitoring site.

## SELENIUM vs. TIME

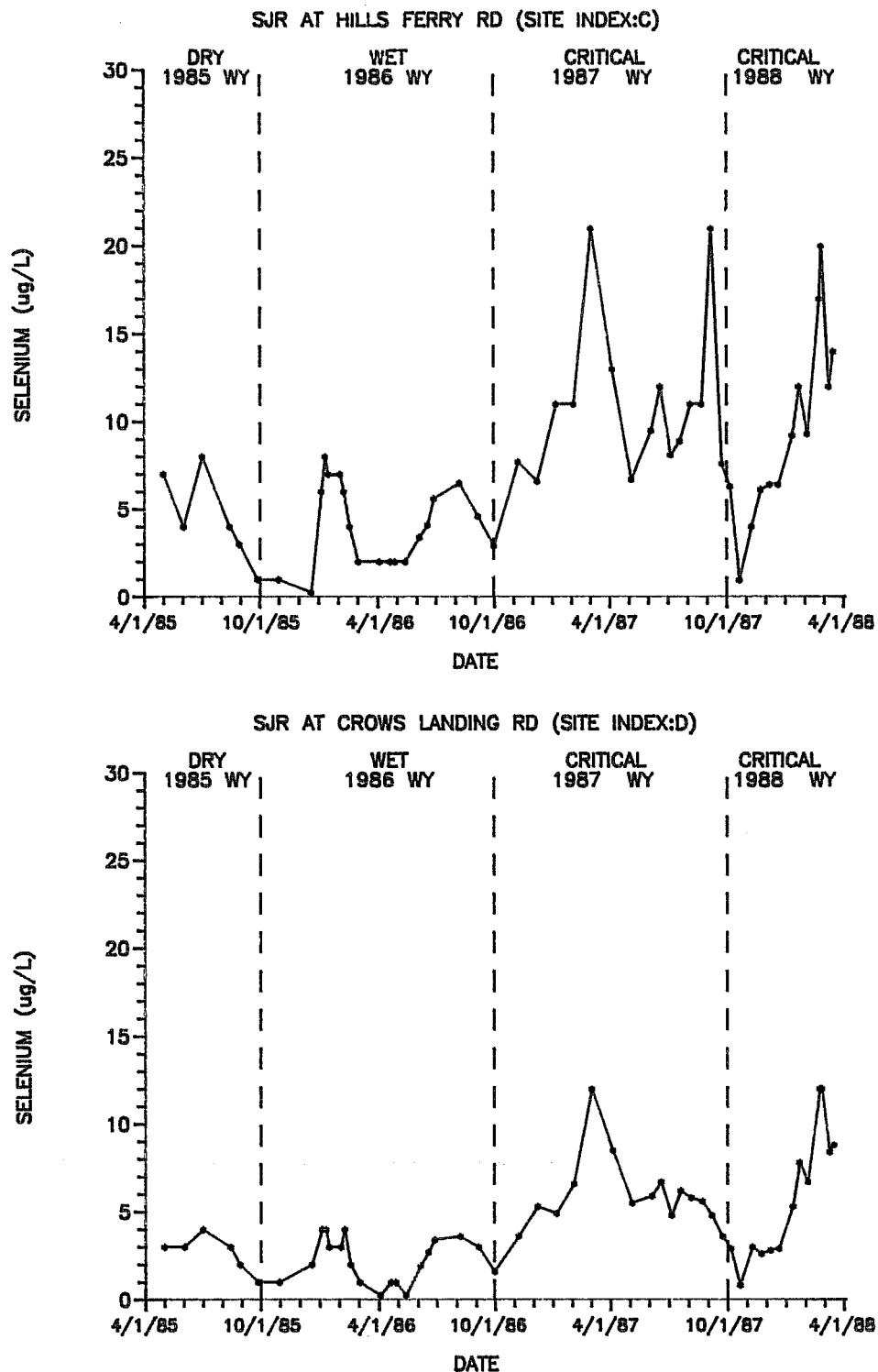
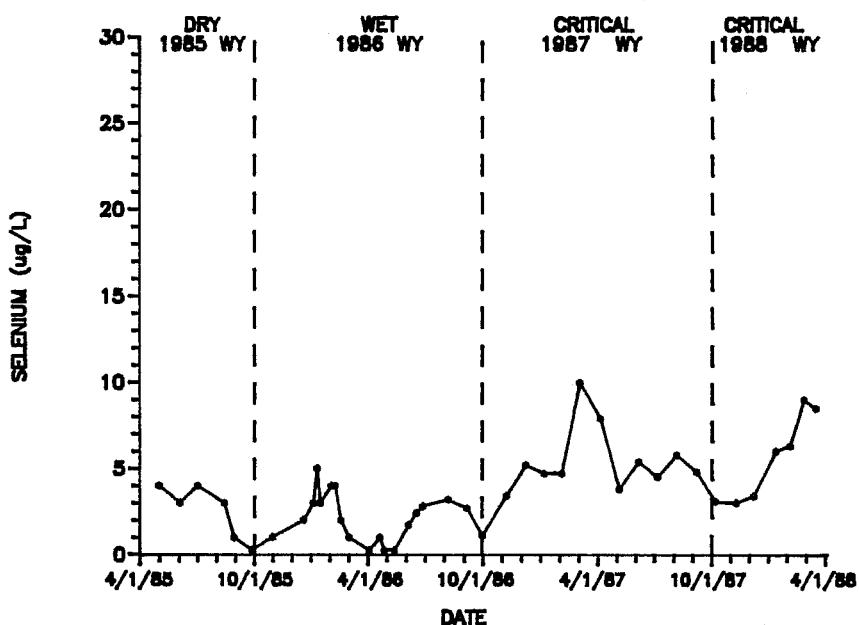


Fig. F1. Selenium vs. time at each monitoring site (cont.)

### SELENIUM vs. TIME

SJR AT LAS PALMAS AVE (SITE INDEX:E)



SJR AT GRAYSON RD (SITE INDEX:F)

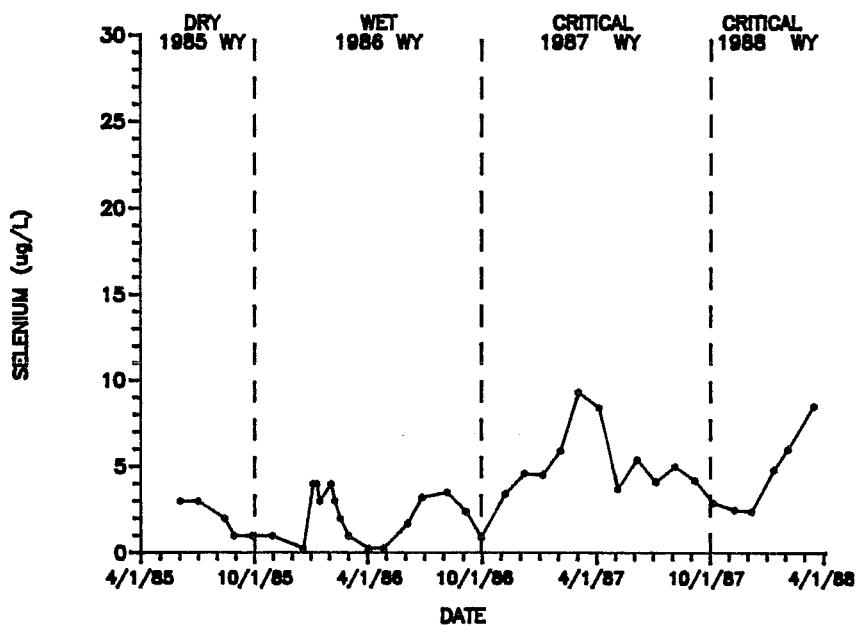


Fig. F1. Selenium vs. time at each monitoring site (cont.).

## SELENIUM vs. TIME

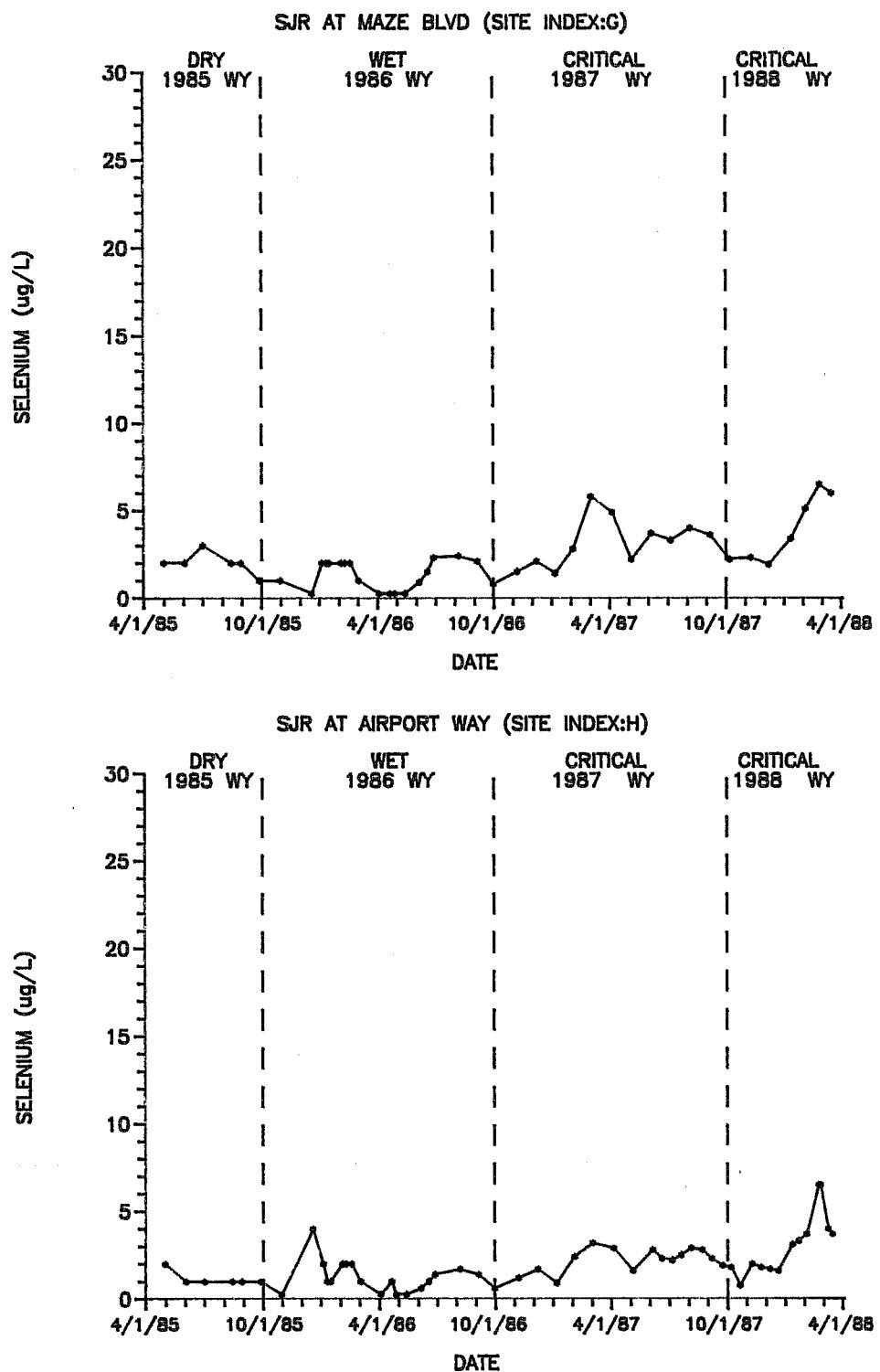


Fig. F1. Selenium vs. time at each monitoring site (cont.).

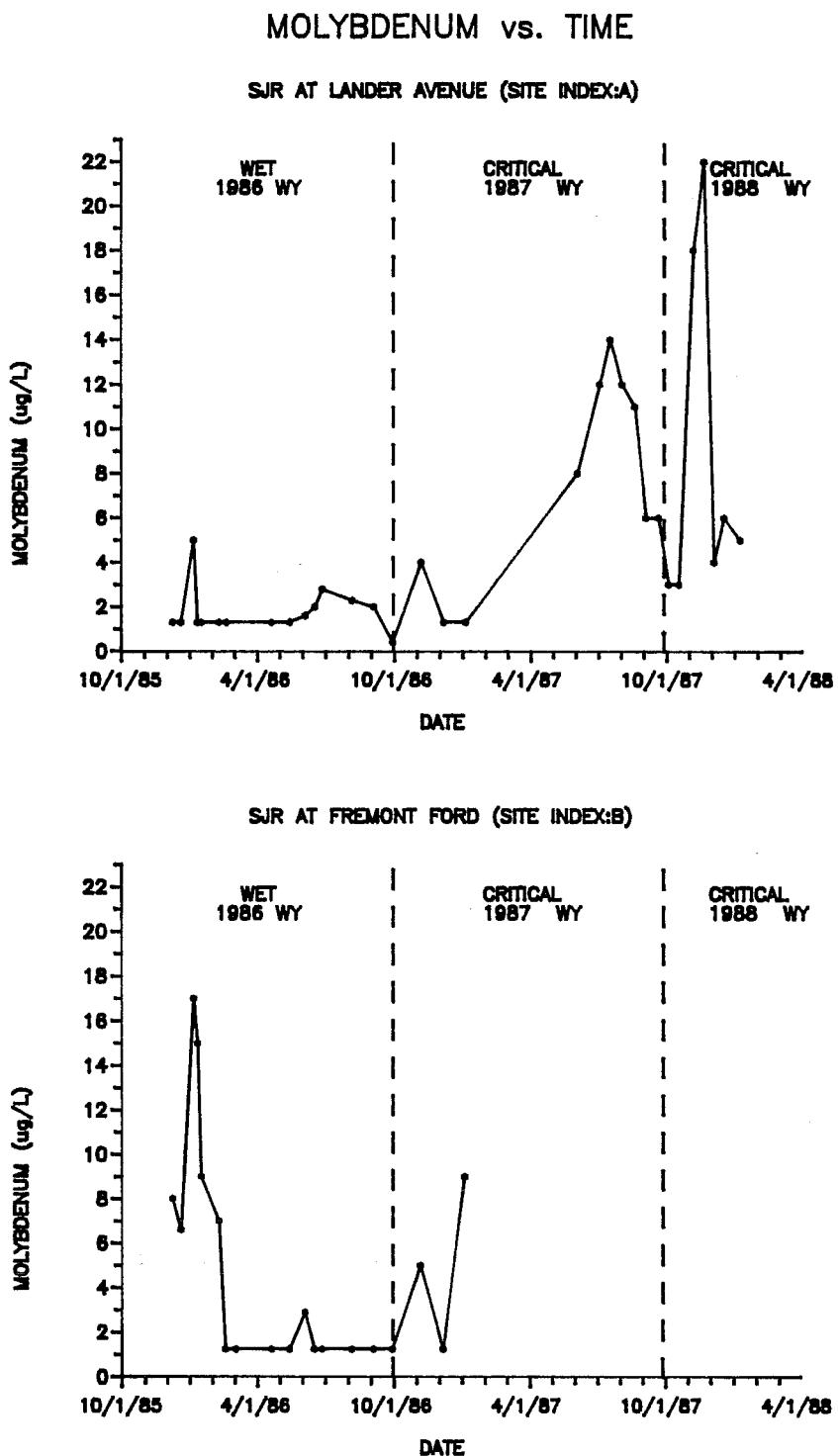


Fig. F2. Molybdenum vs. time at each monitoring site.

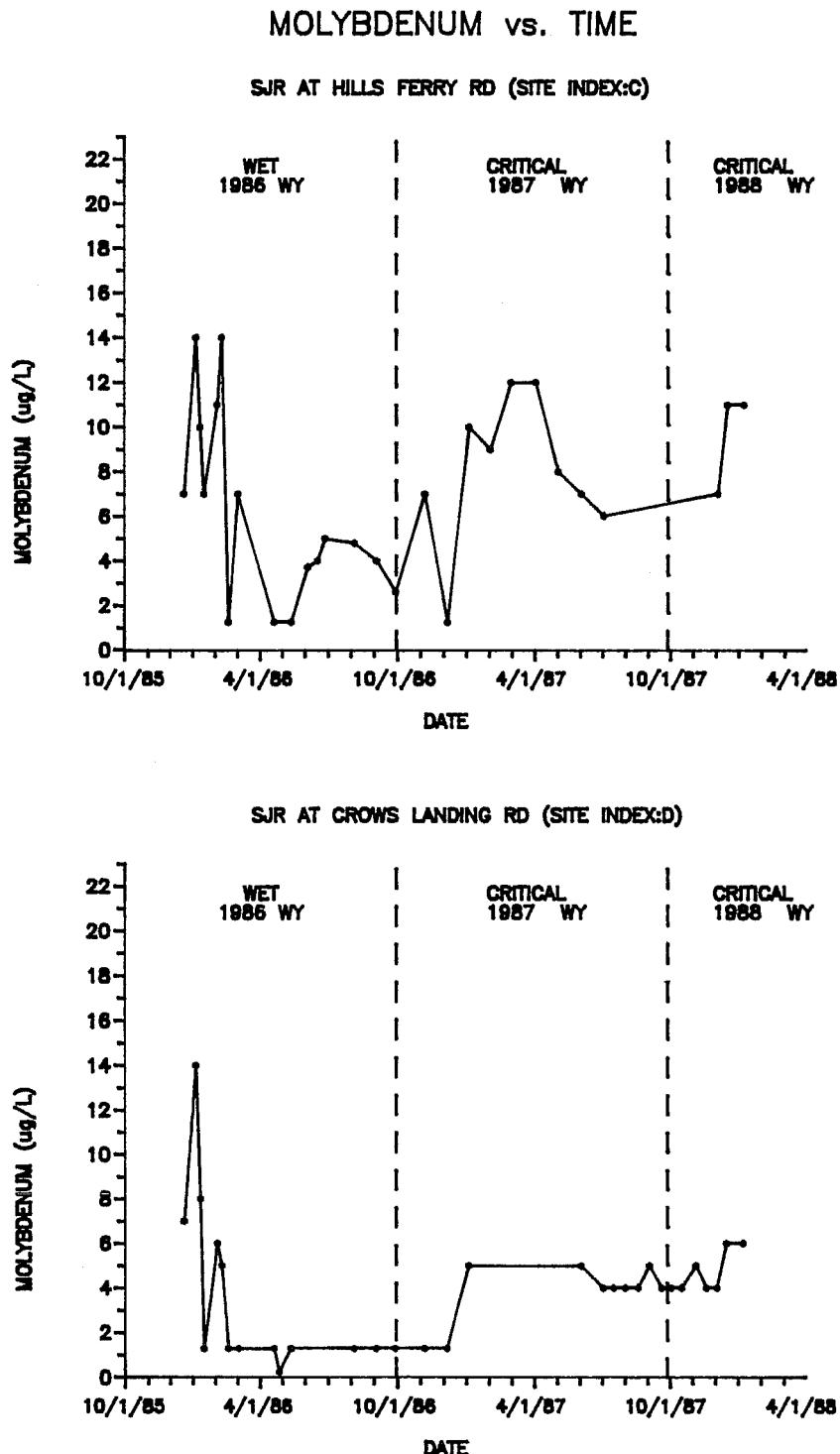


Fig. F2. Molybdenum vs. time at each monitoring site (cont.).

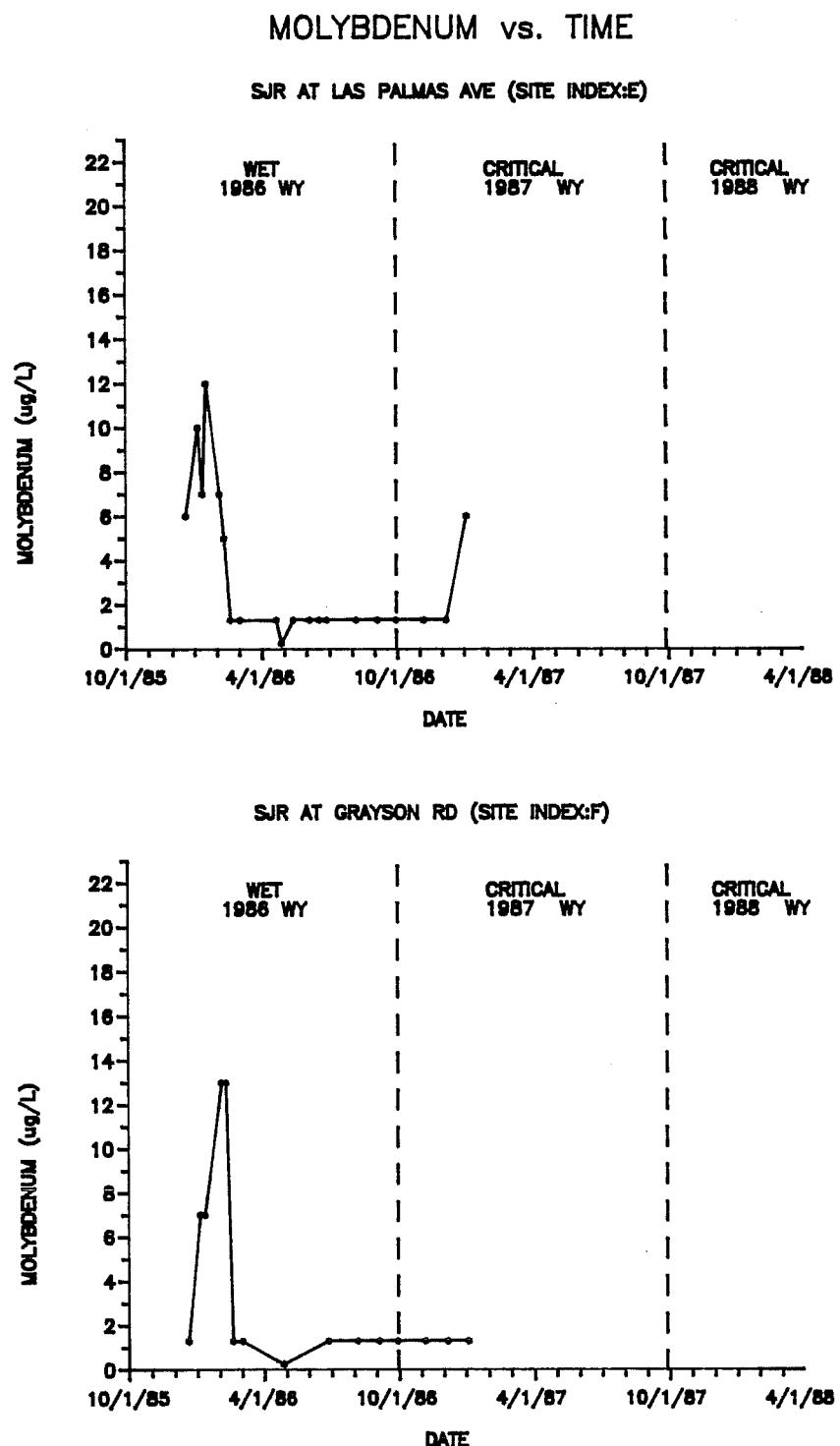


Fig. F2. Molybdenum vs. time at each monitoring site (cont.).

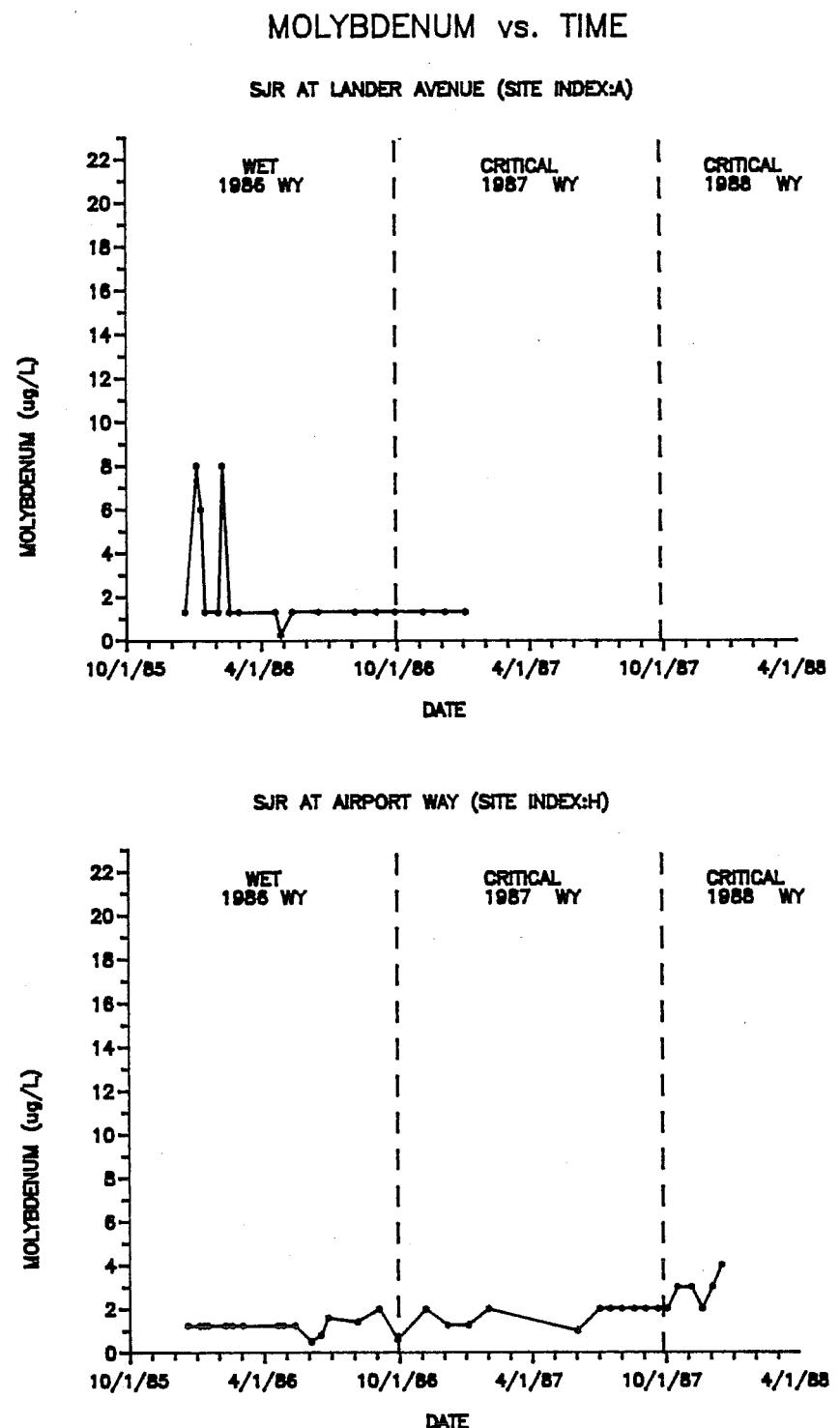


Fig. F2. Molybdenum vs. time at each monitoring site (cont.).